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NATIONAL PARKS IN BRITAIN

WHILE the National Parks Bill received an unopposed second reading in the House of Commons, the course of the debate indicated that some modification might be expected at the committee stage. Dr. Hugh Dalton, indeed, on April 1 went so far as to suggest that members who had ideas on the functions of the commission or the planning authority or any other matters that had been discussed might possibly find their ideas accepted, perhaps in modified form, during the committee stage. There may well be a brisk response to this encouraging, if unusual, pronouncement, though it may be a matter of opinion whether the two most important points on which criticism fastened—the composition of the park planning authorities and the powers of the National Parks Commission—are really committee points as Mr. Dalton suggested.

The Bill makes the National Parks Commission responsible for the preservation and enhancement of natural beauty in England and Wales, and particularly in the areas to be designated under the Act as national parks or as areas of outstanding natural beauty, and for encouraging the provision or improvement of facilities for enjoying the national parks and the opportunities the parks afford for open-air recreation and the study of Nature. Nevertheless, the Commission is to be wholly advisory, and there appears to be no provision for making its advice effective or even to ensure that local authorities act on its recommendations; further, as Sir Arthur Salter pointed out, the Commission is to be advisory in matters upon which it is most unlikely that its advice would prevail against contrary interests.

The full significance of this weakness is only apparent when it is realized that the administration of the national parks and execution of the proposals of the National Parks Commission is to be entrusted to the local authorities, either to the planning board of a single authority, or to a joint board where the area of the proposed park falls into several counties. If the Minister decides to dispense with a joint board, the local planning authorities concerned must have a separate committee to deal with any land in their area which is within the boundaries of the park. At least one quarter of the members of the joint boards, advisory committees or special committees appointed for the purpose must be appointed from persons nominated by the Minister after consultation with the Commission. The preparation of development plans for an area including any part of a national park is to be the responsibility of the local planning authorities, who are to be allowed one year after a national park order made by the Commission comes into effect to formulate proposals, which they must discuss with the National Parks Commission.

Such procedure does not warrant optimism that national parks will come into being at an early date. Moreover, the urgency of the problem arises largely, if not primarily, from the action of Government departments which, as was stressed on all sides in the debate, neither the National Parks Commission nor the local authorities will have powers to

resist. This, however, as the Hobhouse Committee insisted, is the major threat to national parks in Britain, and its reality has been emphasized by what has been happening in regard to Dartmoor and other areas while the Bill has been under debate. There is no confidence, indeed, in the ability of the Minister of Town and Country Planning to resist such pressure. Mr. Dalton's statement in the debate that something like what is proposed in the Hobhouse Report, namely, the submission of matters in dispute to a permanent group of Ministers, is already the practice, might have been better received if the evidence were more convincing that Service departments are not allowed to be judges in their own cause.

In view of Mr. Dalton's statement that an inter-departmental committee of senior ministers is already operative, it is difficult to understand the reluctance of the Government to adopt openly a recommendation which would go far to restore confidence in the genuineness of its support for national parks. As it is, Mr. Silkin, in addressing a meeting of the Ramblers' Association on April 10, still burked the plain fact that if the conservation of Nature and of natural beauty is to mean anything, at some point a National Parks Commission or an inter-departmental committee of Ministers must have the right to over-rule a particular ministry. The Government itself apparently refuses to recognize the implications of the conflicting demands of so many kinds, all based on genuine national interest, for our limited resources of land; and the failure to co-ordinate, in particular, the Services demands for training areas exacerbates a public opinion which, although it fully recognizes the vital importance of setting aside a proper proportion of land for that purpose, rightly declines to admit that each particular demand can be discussed in isolation or without regard to other national interests.

The whole point of the argument for national parks is that there are some areas in which the claims of amenity and of natural beauty must come first; even such a vital interest as defence cannot come first all the time, or there will be nothing left to defend. It could be wished that, in introducing the Bill, Mr. Silkin had shown more clearly that he recognizes amenity or natural beauty as a national need and a public interest, and that its claims have to be weighed along with other public interests—the need for food, for water, for electric power, minerals, military training and the rest. In conservation areas its claims must be given more than the usual weight: in national parks they must preponderate and only be over-ruled in some grave and dire emergency.

Some encouragement may be drawn here, however, from Mr. Silkin's reference to a wider function of the Commission which goes beyond the recommendations of the Hobhouse Committee. The Commission is to be responsible generally for directing attention to any question affecting natural beauty in any part of England and Wales, and will also be responsible for selecting the other areas of natural beauty to which special powers are to apply. These areas will normally be smaller in extent than the national parks and, for that, or some other reason, therefore unsuitable for designation as national parks. That function cannot be adequately discharged unless there is full harmony of purpose between the Commission and the planning committees to whom the executive powers are to be entrusted. If the parks are administered by joint boards or, in the single-county areas, by the special committees to which Mr. Silkin referred, it is not impossible that, in the hands of men and women who care deeply for the purposes the Bill purports to serve, we may see real national parks and not merely local authority parks. What should be remembered is that the proposed composition of the joint planning boards or special committees places a heavy strain on the loyalties of the members appointed by the local authorities—a strain that could reasonably be argued as invidious.

While that contention finds some support in what, for example, has been manifested already in local council elections in the Lake District, it should still be remembered that the main threat to the preservation of natural beauty comes from public authorities, whether they are local or central. The National Parks Bill does, indeed, provide the means for the claims of natural beauty to be advanced as a public interest. Whether representations will be effective against claims of other public interests, both local and central, appears to depend less on the organisation established by the Bill than on our ability to administer its provisions with the determination and imagination which will realize the capacities for good which are undoubtedly inherent in the Bill.

Nowhere is this more apparent than in regard to the further duty to be laid on the Commission of selecting the long-distance footpaths. That duty is complementary to the duty placed on the county councils of conducting within three years a survey of all the public paths in their area, and preparing a draft map showing existing footpaths or bridle-ways. Some county councils, such as those of Essex, Hampshire and West Sussex, have already taken a keen interest in footpaths and done much of the surveying and signposting required. Moreover, their work has already demonstrated how far success in this field depends on co-operation with the urban districts, parish councils, private landowners and voluntary organisations such as the Ramblers' Association and the Commons, Open Spaces and Footpaths Preservation Society.

The progress which some counties are already able to report in this field is one reason for hope, especially as it has indicated practical examples of co-operation between public authorities and voluntary organisations, and some of the financial difficulties in regard to maintenance which hitherto have been responsible for reluctance to implement long-distance footpaths such as the Pilgrims' Way, the coastal paths or the proposed Thames riverside walk from Teddington to Cricklade. The National Parks Commission's selection in this field must clearly be accompanied by recommendations in regard to the cost of maintenance if the Pennine Way and similar proposals are to materialize. The financial clauses of the Bill provide for national contributions for that purpose, as well as to the Nature Conservancy.

So far as Nature conservation is concerned, the Bill supplements the powers conferred by royal charter on the Nature Conservancy and gives local authorities the necessary powers to set up local Nature reserves. Powers to acquire land compulsorily are conferred on the Nature Conservancy where it is expedient in the national interest that the land should be managed as a Nature reserve, or where there has been a breach of any agreement prejudicial to its management. Nevertheless, it is clearly intended that here also the normal method of acquisition or management shall be by voluntary agreement; and the full purpose of Nature conservancy as defined in the Bill—the provision of special opportunities for the study of, and research into, matters relating to the fauna and flora of Great Britain and the physical conditions in which they live, and for the study of geological and physiographical features of special interest, as well as the preservation of flora, fauna or such geological and physiographical features—will only be achieved with the full understanding and co-operation of all those concerned, whether private landowners or occupiers, local authorities, or Government departments.

These parts of the Bill are all linked up naturally with the wider and more controversial question of public access to the open countryside. Given that the Government is in earnest in its determination to stop the piecemeal encroachment of Government departments and make the establishment of national parks really effective, whether the purpose of national parks is achieved depends on public understanding and co-operation. There must be no confusion in the public mind between the different purposes of national parks and Nature reserves; the reasons for the different conditions of access must be clearly understood. Moreover, as was repeatedly emphasized in the debate, national parks in Britain, unlike those in other parts of the world, cannot be divorced from ordinary rural life. In them farming, rural industry and afforestation must function as nearly to normal as possible, and accordingly rights-of-way and public access to open country involve responsibilities and duties. The building up of a higher code of conduct on the part of those who enjoy the new opportunities, and the observance of that code less through penal enactment than under the compulsion of a public opinion that fully understands the reasons for the code, is a far surer way of securing the essential *rapprochement* between townsman and countryman.

This lies at the root of the whole matter; it is a disturbing feature in the life of Britain to-day that estrangement between townsman and countryman so readily arises. Numerous factors contribute to that discord; a significant recent example was the failure of farmers in Derbyshire to join with the Council for the Preservation of Rural England and the Ramblers' Association in opposing the extension of the Hope Valley cement works, although the taking of good farmland for clay-pits was the most vulnerable part of the scheme. The reception of Mr. Silkin's Bill in the House of Commons, however, testified to the existence of a large amount of goodwill and understanding on all sides. Strongly as the claims of agriculture were pressed, they were not advanced to the exclusion of other interests, and the whole spirit of the debate encouraged the hope that a satisfactory compromise between all interests will be found provided the Government deals resolutely with the tendency of Government departments to advance piecemeal proposals and attempt settlements which ignore other interests.

If the goodwill shown in the debate continues during the committee stage, the Act going to the Statute Book may satisfy most of the aspirations so widely entertained since Lord Addison's Committee first explored the question of national parks in 1930. Whatever the form of the Act, much will inevitably depend on Government action, public understanding and the establishment of a fresh harmony between townsman and countryman. Nothing could contribute more to the creation of the right atmosphere than a clear lead from the Government on the vexed question of land for the Services. Given this, and the imaginative and energetic exercise by the National Parks Commission of its functions of publicity and the provision of information services, there may be created a public understanding which will prevent the abuse of rights-of-way and access; further, by easing, if not removing, the clash of loyalties which the entrusting of the administration of the parks to local authorities at present involves, the Act will give Britain a system of parks and reserves which are, in fact and in spirit as well as in conception, truly national.

ORIGIN OF THE UNIVERSE

L'Hypothèse de l'atome primitif

Essai de cosmogonie. Par Prof. Georges Lemaître. (Les problèmes de la philosophie des sciences.) Pp. 203. (Neuchâtel: Éditions du Griffon; London: H. K. Lewis and Co., Ltd., 1946.) 8 francs; 10*s*.

PROF. GEORGES LEMAITRE is the eminent relativistic cosmologist (at one time a pupil of Eddington) who in 1927 independently discovered a solution of Einstein's gravitational equations which made the curvature of space depend on the time and so gave an explanation of the expansion of the universe of nebulæ. Actually he was anticipated by A. Friedmann, who had in 1922 and 1924 discovered forms of the fundamental metric of the homogeneous universe which involved the time; but Lemaître himself has always given the credit for the discovery to Friedmann, even to the extent of barely doing justice to himself. Lemaître's paper, which was published in Belgium, was overlooked by Eddington at the time; but it was due to Eddington that the Royal Astronomical Society published a translation of Lemaître's paper in 1931. In the present volume, Lemaître reproduces *seriatim* five addresses delivered by him on various occasions between 1929 and 1945, the title of the last of them giving its name to the present volume. There is also an inspiring preface by Ferdinand Gonseth, the distinguished professor of philosophy at Zurich. Though there are a few mathematical formulæ in the text, the style is that of semi-popular exposition, and detailed mathematical explanations are confined to an appendix.

The point of view of the author is that of orthodox relativity, and as a persuasive outline of that point of view in relation to world structure the addresses could scarcely be bettered. His account of 'curved space', illustrated by means of a Euclidean map, almost over-reaches itself; for why (the reader is inevitably led to ask), if the map is so successful, does the author consider the curved space as reality and reject the Euclidean equivalent as a mere map? He claims to prove that the number of stars in the universe must be finite, but the proof is question-begging. He believes firmly in the existence of the so-called 'cosmological constant', and believes, too, that it must be positive. But he admits, what is sometimes forgotten, that Einstein's relativistic theory of gravitation teaches us nothing about the signs or magnitudes of the two 'constants' of gravitation, and it is therefore surprising that he should be satisfied that a theory which goes so little into the fundamental nature of gravitation should be capable of explaining the origin and evolution of the universe.

This complacency, and consequent failure to see the need for a deeper theory of gravitation, run right through the volume. For example, his mathematical appendix opens with the unsatisfying statement that *proper time* is "the time for which identical experiences successively repeated have the same duration", when, as every philosopher knows, there is no recipe for saying what is meant by 'successive identical experiences', since you cannot put the fleeting minute side by side with a previous minute. Kinematic relativity, on the other hand, gives a rigorous definition of congruent clocks at a distance in any kind of relative motion, and it is because it really begins with fundamentals that it is able to refine on orthodox relativity to the extent of showing that in different dynamical contexts different scales of time are taken to be uniform.

The hypothesis of the primitive atom, a super-radioactive nucleus, as the origin of the universe and the source of nebulæ, clusters of nebulæ and cosmic rays, may seem at first sight, to the hard-boiled physicist, a mere piece of scientific romancing, but it is most attractively expounded by Lemaître. He admits that he may be pushing his description of the detailed sequence of events too far: an initial period of expansion; then a slowing-down as the universe passes through a near-equilibrium state corresponding to an Einstein universe; lastly, a further period of expansion, with the nebular clusters at a mean density of 10^{-27} gm. cm.$^{-3}$ as the fragments of an Einstein configuration of equilibrium between Newtonian inverse-square attraction and cosmological repulsion varying as the distance, and with cosmic rays as the fossil relics of the initial super-radioactivity. But it is becoming increasingly certain that any theory of evolution must envisage conditions near the natural zero of time drastically different from those now ruling.

Kinematic relativity agrees with the essence of Lemaître's hypothesis in tracing the state of the universe backwards to a point-singularity, before which there was neither space nor time nor becoming; and J. B. S. Haldane's related speculations at least show how some of the most vigorous minds of to-day are reacting in the same sense. The one thing that kinematic relativity insists on with regard to this singularity is that no propositions can be asserted about the state of affairs at that epoch; it is transcendent, as becomes the event of the creation of the universe. Lemaître's identification of this singularity with an actual super-radioactive atom seems to me too definite a thesis to maintain; indeed, too definite to have a chance of being true. But physicists and astronomers who are sceptical about the value of theories of world evolution will at least find food for thought and further reflexion in Lemaître's volume.

E. A. MILNE

SCIENCE AND HUMANISM

Gods and Men

A Testimony of Science and Religion. By Sir Richard Gregory. Pp. viii + 214 + 8 plates. (London: Stuart and Richards, 1949.) 12*s.* 6*d.* net.

SIR RICHARD GREGORY and I have grown old together; his memory and mine go back to the days when religion and science were in open conflict and when Huxley was assuring his hearers that the more the methods of science took hold of mankind the less would be its belief in supernatural powers and influences. Sir Richard was a pupil of Huxley; no one is better qualified than he to bear testimony as to how the conflict has gone in the last sixty years. For forty-five of these years he was editor of *Nature*—a position which entails an intimate knowledge of all branches of science and of the bearing of scientific knowledge on every form of human activity. In "Gods and Men" he states, objectively and dispassionately, the relationship which does exist, as well as the relationship which ought to exist, between science and religion. He does not share my fear that the present truce is an uneasy one; the opposite—he is of opinion that the conflict is a thing of the past and that the future must see an active collaboration of science and religion if mankind is to prosper.

The following paragraph illustrates the manner in which Sir Richard states his case for the reconciliation of science and religion:

"In recent years it has become increasingly evident that this [the doctrine of immortality] and other traditional beliefs cannot have a place in progressive thought apart from scientific knowledge and historical evidence. Responsible leaders in the Church of England to-day represent a new and enlightened attitude towards the so-called 'heresies' of scientific thinkers, which convulsed English society in the nineteenth century from the days of Dean Buckland down to the pitched battles which took place on the scientific positions of Charles Darwin, T. H. Huxley, John Tyndall and their successors" (p. 142).

I do not think that this instance can be accepted as evidence that science is causing religion to lose its hold on the great public. Indeed, Sir Richard recognizes this and admits that *most* church-goers regard "the acceptance of such views as a capitulation to the forces of modernism and scientific materialism". As evidence of the hold that religion has on the public of England I would cite the fact that the most worldly-minded of newspapers adorn their opening page with a biblical text and that at all times the B.B.C. is offering a 'word in season'! Science in nowise hinders the drift of our most eminent literary men from seeking succour in the Roman Catholic Church.

Sir Richard is a devout humanist; for him humanism is a religion. Humanism he defines as "the integration of all human influences which promote the development of the human race, whether it

includes the teaching of a particular religion or not. Whatever principles or practices raise man out of his animal ancestry and add to his status among living creatures can rightly be termed humanistic." Humanists believe that human affairs go forward without interference from supernatural powers. However passionately an ideal for the betterment of mankind is held, unless the overlordship of a Divine power is recognized, that ideal will not be accepted by the orthodox as worthy of the name of religion. Critics might rightly urge that it is humanism, not religion as usually understood, which Sir Richard desires to reconcile with science. Humanism and science need no reconciliation.

Throughout the latter half of "Gods and Men" Sir Richard directs his argument to support a high ideal which he and his life-long friend, the late Mr. H. G. Wells, held in common—the ideal of all mankind being welded into a human brotherhood and becoming members of a single world State. "The essence of all great religious systems," he claims (p. 130), "is belief in the attainment of high ideals by devotion of service to them." If we accept this claim, as men of science are likely to do, then "Gods and Men" may be described as a religious book and its author as an intensely religious man. One bar to the realization of this ideal is the irreconcilability of the doctrinal elements in world religions. But if the doctrinal element is left out of consideration, there remains in all of them a common element—the ethical or moral element. It is out of this common or ethical element that Sir Richard sees the possibility of constructing a "world religion". "In this composite but practical creed," he maintains (p. 131), "it is permissible to consider the movements toward world fellowship as representing a further and higher stage in the development of religious belief, in which the theological differences which antagonize will be forgotten in the pursuit of a common and universal moral purpose."

Huxley believed that as the kingdom of science extended its rule the reign of the supernatural would lose its hold on the minds of mankind. Gregory and I have seen science become an ever more powerful factor in the life of man; but religion has not lost its hold on the human heart. That is because religion was born in the human heart, not in the human head. It answers certain basal needs of the 'heart', that is, of human nature. "The social and cultural conditions change," it is noted (p. 157), "but human nature remains in most respects unaltered". That, I think, is why religion holds its own in spite of the great advance of science. Perhaps it is just the unmalleability of those mental elements which go to the make-up of human nature that now stands as the chief obstacle to the realization of Sir Richard Gregory's ideal—a universal brotherhood.

In writing this book the author has submitted himself to the rigorous discipline of the scientific method; even when dealing with those matters of doctrine, to the handling of which religious minds are most sensitive, his methods of statement remain purely objective. He is critical but never aggressive. Yet his application of the method of science to religious problems seems to have given offence in some quarters. In a literary journal where orthodoxy is upheld, a critic has bluntly stated that "Gods and Men" is a book which should never have been published. The wish to suppress such a book is evidence that the conflict between science and religion is not yet over.

ARTHUR KEITH

ORIGIN AND GROWTH OF THE ROYAL SOCIETY

Scientists and Amateurs

A History of the Royal Society. By Dorothy Stimson. Pp. xiii + 270 + 20 plates. (London: Sigma Books, Ltd., 1949.) 15*s.* net.

IN the present century we have grown so accustomed to the supremacy of the Royal Society in all matters scientific that it is difficult to realize it has not always possessed its high reputation. Such is its authority and its high seriousness to-day that it is hard to believe there have been times when it has been scoffed at and derided for the triviality of its pursuits. Yet this is the case. The Society derives its reputation from the scientific eminence of its members; yet there have been long periods in its history when a majority of those elected to its fellowship have not been men of science at all, when election has been a mark of social rather than of scientific distinction.

Other histories of the Royal Society have been published, written, as histories of institutions often are, by those intimately connected with its administration and drawing on personal knowledge of the various aspects of its affairs. The work under notice is of a different character. It is the outcome of a study by Miss Stimson of seventeenth-century science in England, and as an essential part of that theme, an inquiry into the origins and growth of the Royal Society. The result is a book for the general reader, primarily the American reader, written in a detached and objective manner, and setting the history of the Society against the intellectual, social and historic background of the seventeenth and later centuries. It is an interesting, indeed an absorbing story, and the treatment is original and refreshing.

The title is, I think, a little misleading. It draws a distinction between the professional men of science and those amateurs, the *virtuosi*, who played such a large part in the foundation and the early activities of the Society; but there is a sense in which all true scientific men have remained amateurs, and there are among us, even to-day, some few individuals whose devotion to science is a thing apart from their bread-and-butter interests. In this regimented and socialized age, when we are all classified and labelled, it is well to remember that there are still some who have made great contributions to knowledge, and yet cannot readily answer the question, "What is your profession or occupation?" They have preserved that independence and integrity of mind from which must always spring the advances of the human intellect.

Miss Stimson passes in brief survey the writings of Francis Bacon, the ideas of such men as Comenius and Hartlib, of John Evelyn and Robert Boyle, of Sir Thomas Gresham and his College in the City of London, of the whole movement towards the new learning based on experiment and observation which culminated in the foundation of the Royal Society by Charles II. The meetings of the 'Invisible College' in London and Oxford preceded this royal recognition and encouragement. One of Charles's principal scientific interests was the progress of astronomy as an aid to navigation, and there grew out of this, on the establishment of the Royal Observatory and the setting up of John Flamsteed as the first Astronomer Royal, the association of the Royal Society and the Royal Observatory which has lasted ever since.

Charles's great Navy secretary, Samuel Pepys, was one of the early presidents of the Society. The Society's connexion with the Royal Observatory is closely paralleled in more recent years by its responsibilities for another great national institution, the National Physical Laboratory. From the earliest years the Society has been consulted by the Government in scientific matters, and the advice it has thus been able to give constitutes one of its most valuable public services.

It is well known that King Charles poked fun at the Society "for spending time only in weighing of ayre". There were other and more serious criticisms, in the early years, of the unsubstantial quality of many of the papers published, to which were added financial troubles, and problems of accommodation. Despite the reputation of Newton and the prestige conferred upon it by his presidency, the Society had many difficulties and some opposition with which to contend before it became firmly established. Later, at the end of the eighteenth century, during the long and autocratic presidency of Sir Joseph Banks, there were acute dissensions among the members and strong criticism of the methods of election to fellowship.

Gradually, however, reforms were introduced; scientific attainment was established as the essential qualification for admission of the great majority of the members, and the leading men of science came into control of the administration. By the middle of the nineteenth century, despite the competing activities of the many specialized societies which were being formed, the Royal Society had achieved the position of unchallenged leadership and authority which it holds to-day.

This book is the more valuable because it is obviously the outcome of extensive reading and careful investigation. Miss Stimson has special reasons for her interest in the American contacts of the Society, and has given many interesting particulars of the membership of Cotton Mather, Benjamin Franklin, and other prominent Americans.

THOMAS MARTIN

APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 9: Oils, Fatty—Pituitary Body. With an Index by Dr. J. N. Goldsmith. Pp. viii+671. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1949.) 80*s*. net.

THE national importance of the chemical industry, and of those allied industries which depend upon chemical science, is reflected to-day in the pronouncements of Ministers and the figures of trade. Chemical technology becomes increasingly scientific, and chemistry constantly makes available new knowledge of materials and reactions. It is essential that this new knowledge should be assembled in a convenient form. Moreover, in these days when we are in danger of being overwhelmed by a mere mass of information, it is most valuable to have it filtered and screened by experts.

The appearance of a further volume of the new edition of "Thorpe" is therefore to be greeted with pleasure and gratitude, both because of the wide range and the authoritative treatment of the subject-matter. The present volume, No. 9 in the series, contains articles from some seventy authors, and the general level of the contributions may be indicated by some samples. Dr. E. J. Bowen writes on "Photochemistry", Dr. U. R. Evans on "Passivity", Prof. T. P. Hilditch on "Oils and Fats", Prof. E. L. Hirst and Dr. J. R. N. Jones on "Pectin", and Mr. B. Topley and Dr. B. Raistrick on "Phosphorus". The inclusion of contributions from distinguished overseas authors such as Prof. J. H. Quastel (oxidizing enzymes), Dr. Gustav Egloff (petroleum), and Prof. R. J. Williams (pantothenic acid) is a pleasing feature. The central position of chemistry in science is well exemplified by a comparison of the largely mathematical article of Dr. E. A. Moelwyn-Hughes on "Partition Function" with monographs from the biological end of the subject, such as that by Dr. E. Lester Smith and his collaborators on "Penicillin".

Sir Ian Heilbron and his colleagues on the editorial board are to be congratulated on the general high level of achievement. The world of chemistry is in debt to them and to the authors alike.

R. P. LINSTEAD

A STUDY OF IBO LIFE

Ibo Village Affairs

Chiefly with Reference to the Village of Umueke Agbaja. By M. M. Green. Pp. xi + 262. (London: Sidgwick and Jackson, Ltd., 1947.) 10*s*. 6*d*. net.

THIS book is a valuable contribution to our understanding of the Ibo, not for the facts it contains but for the very clear exposition Miss M. M. Green gives in Part 1 (Village Organisation) of the general, almost conscious, tendency of the Ibo people to disperse authority over as many groups as possible —whether based on age, sex, occupation or anything else—rather than to concentrate it in the hands of any central organisation. There are, as she points out, no recognized bodies, either judicial or legislative, that function to the exclusion of other groups, for any group "can take the initiative and win the day if they can secure enough popular support". Many of the difficulties in establishing indirect rule in this part of Nigeria might have been lessened, if not avoided, if this had been fully appreciated earlier.

Parts 2 (Exogamy) and 3 (Women's Organisation) are of less general application. The argument that the system of exogamy (whereby all the daughters are married into, and all the wives drawn from, other villages) forms one of the strongest links by which villages, in the absence of any political ties, are joined together is probably true of Umueke Agbaja and similar communities where the exogamous unit is the village. Exogamy undoubtedly is a cohesive element; but its effect will obviously be of less political, and even social, importance in other parts of Ibo country where the exogamous unit is the extended family and where large numbers of women spend their life in the village or village group in which they are born.

Miss Green adds an interesting appendix in which she attempts to interpret the Ibo temperament in the light of the conclusions reached by Dr. Murdo Mackenzie, particularly in his book, "The Human Mind". Her views are tentative and are, as it were, merely set out for our consideration. But they are certainly thought-provoking, and investigations along the lines she suggests may well do much to raise the 'iron curtain' which all who have worked among the Ibo feel to exist between the minds of these people and their own.

J. O. FIELD

NEW EVIDENCE ON THE STRUCTURE OF SOME PROTEINS FROM MEASUREMENTS WITH POLARIZED INFRA-RED RADIATION

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CURRENT views on the structure of keratin, myosin and related proteins are based on chemical analyses and on X-ray diffraction data. The X-ray evidence (Astbury and Street[1]) shows that these proteins may exist in either of two forms, α and β, each of which shows a characteristic X-ray diffraction photograph. The most intense meridian reflexion corresponds to a chain spacing in the α-form of about 5·1 A., while in the β-form the chain spacing is about 3·3 A. Since it is possible, after suitable softening treatment, to change a natural protein in the α-form to the β-form by stretching or squeezing, it is generally assumed that the polypeptide chains in the α-form are folded in some way, whereas the β-form corresponds to the extended chain. Astbury[2] has proposed a particular form of folding for α-keratin; Huggins[3], Wrinch[4], and Wrinch and Jordan Lloyd[5] have suggested a number of other possibilities. In an interesting recent paper by Astbury, Dalgleish, Darmon and Sutherland[6] the properties of some synthetic polypeptides and natural proteins have been discussed, both from the point of view of X-ray diffraction and infra-red absorption.

We have been engaged in applying measurements made with polarized infra-red radiation to problems of high-polymer structure and have been working on synthetic polypeptides prepared in this laboratory (Hanby, Waley and Watson[7]). An interesting result observed in oriented polyglutamic ester and in α-keratin has already been briefly reported (Ambrose and Hanby[8]). In oriented (rolled) polyglutamic ester and in keratin obtained from porcupine quill, the preferred direction of the N—H bonds is shown by polarized infra-red measurements to be parallel to the chain orientation. This strongly supports the view that the backbone or chain is folded to form a seven-membered ring as indicated by them[8] and shown in Fig. 1. A fold of this kind differing from the above only in the arrangement of the side-groups has been suggested by Huggins[3]. The arrangement of the side-groups shown in Fig. 1 transforms more easily into the β-form and will fold about an axis parallel to the plane of the rings.

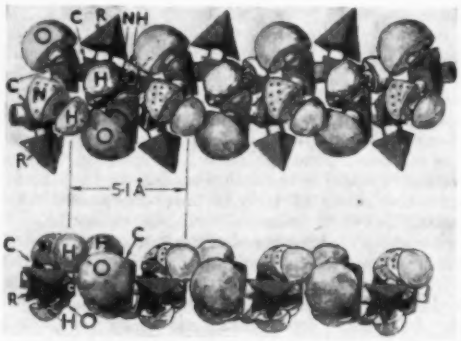


Fig. 1. Two views of polypeptide chain in the α-fold. Only the first carbon atom of each side-group is shown

In view of the importance of the interpretation of the α-structure, we have examined several proteins of the keratin–myosin group. The results, described below, are all in harmony with those obtained in the first instance with polyglutamic ester and α-keratin.

Experimental Evidence

The spectra were recorded in the 3-μ region with a lithium fluoride spectrometer equipped with a selenium transmission polarizer (Elliott, Ambrose and Temple[9]), and tracings are shown in Fig. 2. The keratin specimens were cut sections of porcupine quill (α-keratin) and of swan quill (β-keratin). For orienting specimens of myosin and tropomyosin, the proteins were cast on thin films of rubber, which were afterwards stretched. This technique, which we believe to be new, solved a difficult problem. It was found that cast films of tropomyosin often showed some orientation after drying; this is, no doubt, a consequence of the fact that the material forms fibrillar aggregates in solution (Astbury, Reed and Spark[10]). The myosin was prepared by Edsall's method[10], and tropomyosin was made according to the description given by Bailey[11].

The main features of all the spectra are the bands due to stretching frequencies of the C—H bonds at about 2,900 cm.$^{-1}$, and two bands which almost certainly arise from N—H stretching modes, a strong band at about 3,310 cm.$^{-1}$ and a much weaker one at about 3,060 cm.$^{-1}$. Both N—H bands show parallel dichroism in myosin, tropomyosin and α-keratin, but are markedly perpendicular in feather keratin, which occurs naturally in the β-form (Astbury and Marwick[12]) and is highly crystalline.

Interpretation of Spectra

These facts can be interpreted, as already stated, if it is assumed that the polypeptide chains are folded in the α-form and extended in the β-form. It may be argued that the differing dichroism may arise from the nitrogen atoms on the side-chains; but it is generally considered that the nitrogen is present in the side-groups as $\overset{+}{N}H_3$, and from observations which we have made on glycine ($\overset{+}{N}H_3\ CH_2\ \overset{-}{C}O_2$), the zwitterion form appears to give rise to a very broad absorption band extending from about 2,900 to 3,400 cm.$^{-1}$, with a maximum at 3,160 cm.$^{-1}$. It seems, therefore, that though the side-chain $\overset{+}{N}H_3$ will contribute to the general level of absorption, the bands at 3,060 cm.$^{-1}$ and 3,310 cm.$^{-1}$ can be attributed to the polypeptide N—H linkages. It appears reasonable to assume that in α-keratin and in the α-forms

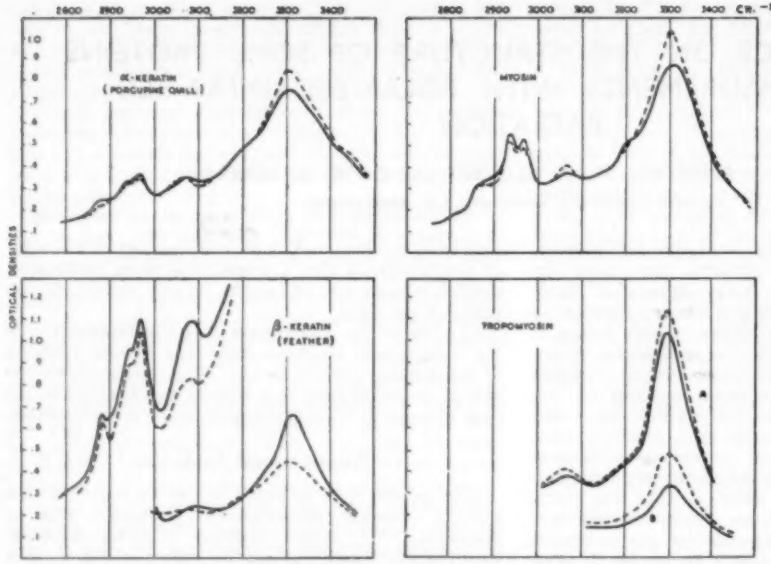


Fig. 2. Infra-red spectra of proteins, using polarized radiation. Full and broken lines show spectra with the *E*-vector respectively perpendicular and parallel to the chain axis. In the tropomyosin spectrum, *A* was obtained with a specimen self-oriented on drying; *B* was a thinner specimen stretched on rubber film. The high-frequency band in β-keratin was obtained with a thinner specimen than that used for the lower-frequency region

of myosin and tropomyosin the same backbone structure is found as in polyglutamic ester, since the same type of dichroism is found in the N—H bands in all these molecules. Without the work on a polypeptide in which there is no nitrogen on the side-groups, one would, however, hesitate to propose a structure for the protein backbone from the infra-red observations.

The weak band at 3,060 cm.$^{-1}$ is ascribed by Astbury, Dalgleish, Darmon and Sutherland[6] to a type of hydrogen-bonded N—H. It is sensitive to changes in structure; for example, Astbury *et al.* found that it weakened in tropomyosin on changing from the α- to the β-form, and we have found that it is weakened in nylons by melting, and by solution in *iso*butyl alcohol. In the proteins we have examined it shows the same type of dichroism as the strong N—H band, generally giving a somewhat higher dichroic ratio. Although a weak band, it may be structurally important, since the low frequency suggests strong hydrogen bonding.

Attention may be directed to the great similarity in the C—H stretching frequencies in α- and β-keratin (apart from the much higher density in the β-specimen caused by the use of a thicker specimen). The similarity of the three peaks includes frequency, relative intensity and dichroism. This may be taken to mean that the arrangement of the side-groups relative to the fibre axis is not greatly different in the two forms. The contrast with the N—H frequencies is striking.

Discussion of Proposed Model

The arrangement shown in Fig. 1 appears to be the one which will give the highest parallel dichroism for the N—H absorption bands. The structure proposed by Astbury[2] gives little preferred direction for the N—H bonds; other arrangements proposed by Huggins[3] as alternatives to his 'α'-fold would give low dichroism also. The spiral shown by Huggins in Fig. 13 of his paper also appears to give about the required amount of parallel dichroism. Although possibly fitting the X-ray observations rather better than the 'α'-fold, this spiral has the serious objection that it is practically rigid. Moreover, the α–β transition would require that many of the side-chains would have to rotate through an angle of 180°, which in a material such as keratin containing numerous intermolecular cystine and salt linkages seems highly improbable. Calculation based on densities, unit-cell dimensions and residue weights do not allow a choice to be made between four or three residues per unit cell, and hence do not discriminate between the 'α'-fold and the spiral. Although the dichroic ratios shown in Fig. 2 are not high, the result for tropomyosin shows a dichroic ratio almost as high as we have obtained for the same N—H band in a rolled nylon specimen, though in nylon, of course, the band is of perpendicular character. We have pointed out elsewhere[16] that in nylon (as in other polymers) the dichroism of many bands is not as high as the orientation of the crystalline regions would lead one to expect, taking into account the known direction of the covalent linkage involved, which, in the case of the nylon N—H linkage, is perpendicular to the chain axis. We feel, therefore, that the evidence favours the structure which would show the greatest parallel dichroism in the proteins examined.

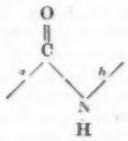
X-Ray Data

The true repeating unit along the fibre axis for the model shown in Fig. 1 is 5·1 A. Huggins[3] considers that it is necessary to assume that alternate side-chains are more potent scatterers of X-rays in order to account for the intensity of the 5·1 A. reflexion. Possibly a slight bending or staggering of side-chains of neighbouring molecules resulting from *inter*-chain salt linkages will account for the intensity.

MacArthur[17] has resolved two strong equatorial reflexions of 9·2 and 10·5 A. spacing in α-keratin. One of these, possibly the 9·2 A. spacing, may correspond to the side-chain spacing as in β-keratin, while the other of 10·5 A. may correspond to the spacing between pairs of α-ribbon molecules. The α-ribbons will presumably run alternately parallel and anti-parallel (with respect to the —NH—CO—CH*R*— units along the chain), as they are thought to do in β-keratin (Huggins[3]). These pairs of chains may be packed in a hexagonal array; Perutz has discovered a hexagonal packing of α-folded chains in hæmoglobin crystals.

We have made a scale model of a length of the polypeptide chain in the α-folded state, using models which allow free rotation around bonds and also a deformation of ± 6° from the normal valency angle. These models were initially designed by Dr. G. S. Hartley and further developed in this laboratory. The models consist of wooden spheres with flat surfaces in which are inserted the female portions of press studs. A suitable brass link connects a pair of atoms, the spherical portions of which are made to the van der Waals radius. In the case of the carbon atom, the wood is cut away to such an extent that only the flat sides of a tetrahedron are left. Fig. 1 shows a drawing made from a photograph of the α-ribbon. The model shows that there is no steric hindrance, and if the hydrogen bonds are represented by rubber bands it is found to be quite easy to fold the ribbon-like structure into larger folds with only a small change of angle between the N—H and C=O bonds, and without noticeable distortion of the valency angles. This secondary folding is discussed below.

Huggins has pointed out that his '*a*'-structure transforms readily into the β-form. It is only necessary to rotate the



linkage about the bonds (marked *a* and *b*) which attach them to the asymmetric carbon atoms in order to pass from the α- to the β-form or *vice versa*. With the structure shown in Fig. 1, there is the additional advantage that the positions of the *R* groups with respect to either the same chain or to neighbouring chains are not altered, apart from an increase in the spacing between neighbouring side-groups along the fibre axis. In keratin, the α–β transformation can be effected without breaking the numerous cystine linkages between chains. The C=O and N—H groups simply move over into planes approximately at right-angles to the planes containing the side-groups and are juxtaposed to the C=O and N—H groups of the neighbouring chains.

The α-form possesses considerable stability; for example, in polyglutamic ester a 500 per cent extension can be effected without destroying the α-ribbon[8]. The hydrogen-bonding forces operate at considerable mechanical advantage in this structure and simply serve to maintain the seven-membered ring. A small amount of tension does not stretch the hydrogen bond appreciably but is taken up by the resistance of the primary valency bonds to deformation.

Speculations on the Macroscopic Properties of Proteins

The model proposed for the α-fold suggests possible interpretations of macroscopic properties in terms of molecular structure; these are put forward rather as suggestions which it is hoped may stimulate further work than as firmly founded deductions. For example, it is possible to explain the elastic properties of wool and other keratin fibres as due to the stretching of hydrogen bonds, without any other molecular rearrangement. The ability of a flattened fibre to recover its shape (Astbury and Woods[14]) on exposure

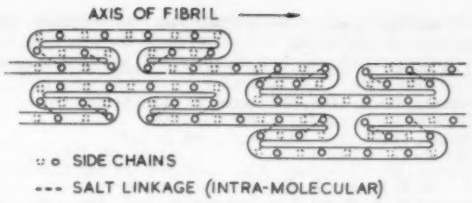


Fig. 3. Suggested secondary folding of α-ribbon to produce contraction in myosin. The side-chains are alternately above and below the plane of folding

to water will only involve the re-closing of extended rings.

The α–β transformation provides an extension of 35–40 per cent on the proposed model. Astbury and Woods consider that a chain extension of about 100 per cent is necessary in view of the 100 per cent extensibility of wool and other keratin fibres. It should, however, be noted that the β-structure already appears at 30 per cent extension, and this may indicate that the molecules which were completely oriented in the original fibres have now been fully extended. Changes of cellular structure and plastic flow may also be involved in further extensions. Astbury and Woods have pointed out that the molecules of fibres stretched in steam are in a more mobile state than those of the original fibre. The 500 per cent extensibility of polyglutamic ester without destruction of the α-ribbon would seem to be significant.

An interesting possibility is that the shortening of myosin fibres which occurs in muscular contraction could result from a secondary folding of the α-ribbon without any violent molecular rearrangement. One possible method of effecting this fold has been suggested to us by Dr. Conmar Robinson (Fig. 3). It allows close packing of neighbouring chains to occur both in the folded and in the unfolded state. The *intra*molecular salt links shown may play a part in causing contraction. Naturally, many features are not explained by this simple picture, but it forms a starting point for further consideration. Possibly the role of actin in muscular contraction is to prevent *inter*molecular salt links in the myosin, which would allow the *intra*molecular links to function, for at the iso-electric point an isolated chain would tend to contract in order to reach a condition of minimum potential energy. Muscular contraction cannot be explained in terms of α-folding alone, because a muscle can contract by more than 50 per cent of its resting length in the body, and Astbury[13] has observed that relaxed muscle gives an α-type X-ray diagram.

It seems possible that the ribbon type of structure may occur in globular proteins. Perutz[15] considers that the fundamental unit of pattern in hæmoglobin is the same as that which occurs in α-keratin. The ribbon-like structure shown in Fig. 1 can certainly be folded back on itself very easily.

We should like to express our thanks to Dr. E. M. Crook, of University College, London, who very kindly prepared the tropomyosin specially for us, to Mrs. Harkness of the same laboratory, who prepared the Edsall myosin, and to Dr. Edward Hindle, who provided the porcupine quills. We are indebted to our colleagues, Dr. Conmar Robinson and Mr. W. E. Hanby, for helpful advice and practical assistance, and to Dr. C. H. Bamford for useful discussion. In conclusion, we wish to express our thanks to Messrs.

Courtaulds, Ltd., for permission to publish an account of our work.

[1] Astbury, W. T., and Street, A., *Phil. Trans. Roy. Soc.*, A, **230**, 75 (1931).
[2] Astbury, W. T., *Chem. and Indust.*, **60**, 491 (1941).
[3] Huggins, M. L., *Chem. Rev.*, **32**, 195 (1943).
[4] Wrinch, D. M., *Proc. Roy. Soc.*, A, **160**, 59 (1937).
[5] Wrinch, D. M., and Jordan Lloyd, D., *Nature*, **138**, 758 (1936).
[6] Astbury, W. T., Dalgleish, C. E., Darmon, S. E., and Sutherland, G. B. B. M., *Nature*, **162**, 596 (1948).
[7] Hanby, W. E., Waley, S. G., and Watson, J. S., *Nature*, **161**, 132 (1948).
[8] Ambrose, E. J., and Hanby, W. E., *Nature*, **163**, 483 (1949).
[9] Elliott, A., Ambrose, E. J., and Temple, R. B., *J. Opt. Soc. Amer.*, **38**, 212 (1948).
[10] Astbury, W. T., Reed, R., and Spark, L. C., *Biochem. J.*, **43**, 282 (1948).
[11] Bailey, K., *Biochem. J.*, **43**, 271 (1948).
[12] Astbury, W. T., and Marwick, T. M., *Nature*, **130**, 309 (1932).
[13] Astbury, W. T., Croonian Lecture, *Proc. Roy. Soc.*, B (1947).
[14] Astbury, W. T., and Woods, H. J., *Phil. Trans. Roy. Soc.*, A, **232**, 333 (1933).
[15] Perutz, M., *Research*, **2**, 52 (1949).
[16] Elliott, A., Ambrose, E. J., and Temple, R. B., *J. Chem. Phys.*, **18**, 212 (1948).
[17] MacArthur, I., *Nature*, **152**, 38 (1943).
[18] von Muralt, A. L., and Edsall, J. T., *J. Biol. Chem.*, **89**, 366 (1931).

NUFFIELD COLLEGE, OXFORD

By D. N. CHESTER
Official Fellow of the College

ON April 21 the Chancellor of the University of Oxford, Lord Halifax, laid the foundation stone of Nuffield College. On present plans it is likely that the Fellows will move into the first section of the building towards the end of 1950. The section under construction is but a small part of the whole, and it is likely to be a very long time before the full scheme is anything like nearing completion. Nevertheless, a most heartening beginning has been made. The site, which is opposite to the Castle half-way between Carfax and the railway station, was chosen by Lord Nuffield because he wished to see that side of the city improved. The building is in traditional Oxford style with exterior of Clipsham stone, and the architects are Harrison, Barnes and Hubbard.

In another and truer sense the College already exists. For it has a Warden and eight official Fellows (with three more taking up appointments shortly), three research Fellows, eighteen graduate Students, as well as a number of professorial, faculty and visiting Fellows. The development of the College, therefore, is in advance of the buildings, which is a healthy sign. The temporary premises at present in use are, however, uncomfortably crowded, and the new building is very much needed.

The College differs from other Oxford colleges in certain important ways, apart from the obvious difference of being a mere unproved infant among a collection of ancient and already distinguished foundations. The two main differences are: the College is primarily concerned with one broad field —social studies—instead of catering for the whole range of university studies; and it is a graduate and not an undergraduate college.

Lord Nuffield gave the University the site and the sum of £900,000 for the building and endowment of a college "to encourage research, especially but not exclusively in the field of social studies, and especially by making easier the co-operation of academic and non-academic persons". The Oxford college system tends to separate people who are working in the same field and throw them into close association with those concerned with other subjects; in contrast, 'Red Brick University' tends to departmentalize particular subjects or fields of study and provide for little contact between experts in different subjects, except on matters of university administration. Both systems have their merits and their disadvantages. There is perhaps nothing so narrowing as the constant and exclusive company of specialists in the same subject; but, on the other hand, progress in that particular field may well be quicker for that concentration.

It remains to be seen whether Nuffield College can get the best of both worlds. Much depends on the interpretation given to the phrase 'social studies'; at the moment the College has among its Fellows those concerned with economics, statistics, social and political theory, colonial and international affairs, government and public administration, industrial relations, social medicine, law, modern and economic history. Moreover, many of the Fellows are connected with other colleges, and so have contact with what is happening in other fields of university teaching at Oxford.

Social studies (the term is preferred in Oxford to 'social sciences') have been a comparatively neglected branch of university activities. Thanks, however, to the increased Government grant following upon the Clapham Report and to the quickening of interest due to the War, this branch of university work has recently made quite big strides. Nevertheless, it is doubtful whether these have been as great as those which have been taking place in the natural and physical sciences and in medicine. At a moment when there is so much talk about research into social and economic problems, it is by no means certain that much more is being undertaken now than immediately before the War, very largely because all the University staffs are so busily engaged in coping with the big increase in the number of students, and with tackling the many problems of university administration. Nuffield College has not gone unaffected by the present heavy teaching demands, for, though it is a graduate college devoted to research, the Fellows have been making a contribution to university teaching and examining, particularly by lecturing and by holding advanced seminars. Even so they have been fortunately free of the crushing burden of teaching and college duties which prevents so many Oxford tutors from writing and research. It is doubtful whether the solution of the problem is the separation of research from teaching—constant teaching without the opportunity for wider reading and research in one's special field is frustrating and narrowing, while research separated from the normal, active life of a university is neither a good thing in itself nor satisfying to most researchers. The long-run solution, therefore, is to reduce the teaching load on university teachers in general so that they may have more time for research. Even then, however, there should still be a place for one or two well-endowed graduate colleges or institutes in particular fields. Such organisations should be able to provide a training for the student undertaking his first piece of research. They should provide a temporary base for scholars from Great Britain and other countries who wish to take a year or so off from teaching to complete a particular project. They should be in a position to help in all kinds of ways those in the university primarily concerned with undergraduate teaching, if only by providing a centre and a first-class research library. Further, their full-time

Fellows would have a special responsibility, if only by reason of their freedom from undergraduate teaching, to play a major part in advanced teaching and graduate studies, and the undertaking of major pieces of research.

A second main difference is that Nuffield is a graduate college. The College may have not more than forty Students at any one time, and these must be reading for the degrees of D.Phil., B.Litt. or B.Sc., or be otherwise engaged in or contemplating approved research. A purely graduate college is, of course, something of an experiment in Great Britain. It is particularly striking that the development should have taken place in a university whose main pride, and rightly so, is in its honours schools. But this year there are about a thousand students reading for advanced degrees in Oxford, the great majority being in medicine or science, so that while increasing the numbers passing through the various honours schools and maintaining the same high standard, the University is also making a major contribution to training of research workers. In medicine and the physical and natural sciences, the graduate finds a base and a place for meeting other researchers in his broad field in the hospital and the laboratories. In social studies he is liable to find himself rather isolated, particularly if he did not take his first degree in Oxford. He has his supervisor, but he does not fit very easily into the college of which he is a member, for the great majority of the other students will be reading for their first degree. By being also associated with Nuffield College, however, he is brought into close contact with other advanced students in social studies. Already, by providing daily lunches at which Fellows and students eat together, by holding special seminars and in various other ways, the College is going some way to provide a corporate life for graduate students in social studies. When at some future date the buildings are complete, there will also be a residential centre.

The main problem at the moment is to find first-class graduates capable of undertaking advanced work in social studies and to keep hold of them. The College offers studentships which may be up to £300, according to needs. At present, however, there is a very heavy demand from Government departments, industry, the universities, and from many other quarters for those who have just graduated with good honours degrees in economics, etc. In many cases, when we have been fortunate enough to get hold of first-class graduates, they have gone off within one or two terms to some attractive university appointment. This is only to be expected at the moment, and we have been glad to have had such capable young men associated with us, even for a short time. It is probably true to say that many of those and of our existing Students would have been lost for university work if Nuffield College had not been able to give them financial aid, for though there are many scholarships and grants available to undergraduates, there is little money for the student who wishes to continue beyond his first degree. It is to be expected that as the present pressure of demand declines, more students will be available for post-graduate work in social studies.

One final point: the founder in his wisdom saw that research in social studies might well be arid unless the College was brought into direct and close contact with practical affairs. There is thus the phrase in the statute governing the College: "to encourage research . . . especially by making easier the co-operation of academic and non-academic persons". This co-operation is helped by the College having visiting Fellows, chosen for their ability to further research in the College by virtue of "their practical experience in the professions or in industry or commerce". They are full members of the College and its governing body. At the moment the College has six visiting Fellows: Lord Beveridge, Mr. Harold Clay, Sir Geoffrey Heyworth, Mr. Herbert Morrison, Sir Raymond Streat and Sir John Henry Woods. It is of great value to have such distinguished men of affairs as these associated with the College and willing to give help and advice in the studies being undertaken there. Another method of co-operation, which owes so much to Prof. G. D. H. Cole and Lord Lindsay, is the private conferences held from time to time. The College invites some forty or fifty people drawn from industry and commerce, government and public affairs and the universities to discuss one or more questions of current importance. During the summer two such week-end conferences are to be held to consider certain problems raised by large-scale organisations and the nationalized industries.

THE GENETICAL SOCIETY

THE Genetical Society holds its hundredth meeting in Cambridge on June 30 and July 1. A number of foreign guests are being invited to the meeting, at which it is planned to present a picture of the growth of genetics and its scope in Britain to-day.

The Society was founded in 1919 by William Bateson, its first president being the Earl of Balfour, whose name is also associated with genetics in the title of the Arthur Balfour chair at Cambridge. Lord Balfour held the office of president until his death in 1930, when he was succeeded by Prof. R. C. Punnett. Since that time it has been customary for the presidency to be held by a professional geneticist for a limited number of years.

The aim of the Society is "to promote the Advancement of Genetics and intercourse among persons interested in that science", and it accepts to membership those who are or have been engaged in genetical research or teaching in the applied genetical fields of plant and animal breeding, or are in other ways attached to the study of the subject. Ordinary membership is thus in no way narrowly restrictive, and, indeed, it now stands at nearly two hundred. In addition, there are twenty overseas members who between them cover most parts of the world. The Society also elects to honorary membership eminent geneticists both from Great Britain and from overseas.

The hundredth meeting is being held just thirty years after the Society was founded—an average of some three meetings a year. These meetings normally take one or other of three forms. For some of them members submit papers dealing with their own researches. Others are organised as symposia on subjects of general interest, contributions being arranged by invitation. These symposia have often been organised and held in collaboration with some other learned society. Thus, genes and chromosome behaviour have been discussed jointly with the Society for Experimental Biology, disease resistance as it relates to plant and animal breeding with the Association of Applied Biologists, the genetics of fungi with the Mycological Society, and micro-organisms with the

Biochemical Society. The third form, which is generally adopted for the summer meetings, is that of visits to genetical laboratories or other places of interest to geneticists. On these occasions primary emphasis is placed on seeing the work in progress and the methods which are used there.

The Genetical Society played a large part in the Seventh International Genetical Congress held in Edinburgh in 1939. It has also always taken the opportunity of inviting geneticists from overseas, who might be visiting Britain, to attend its meetings and to read papers. In this way many eminent geneticists have been the guests of the Society, including the two Nobel Laureates in genetics, T. H. Morgan and H. J. Muller. Since the War a still more positive international policy has been adopted. Scarcely, in fact, was the War over before, in November 1945, the Society held a conference to which were invited geneticists from most of the western European countries and from the United States. Accounts were presented of the progress of genetical work in Britain during the war years, and the foreign visitors described activities in their own countries. Coming when it did, this meeting was appreciated by all as being not only a very happy occasion, but also one of the greatest value in renewing personal exchange of views, and going far to remedy the difficulties caused by lack of free communication during the war years. A further and similarly successful international conference was arranged in 1948 on genetics in relation to cancer problems, this time in co-operation with the British Empire Cancer Campaign.

The history of the Genetical Society is one of steadily increasing membership and steadily widening interest. The growing importance of genetics for other branches of science has been reflected in the Society's co-operation with other bodies in joint discussions. The growing strength of genetics has equally been reflected in the international conferences that have been held. Genetics has, indeed, changed and grown profoundly in the last thirty years, and the process is accelerating rather than declining. The Genetical Society has a great part to play in these changes if it is to serve the science in the future as it has done in the past. It must not merely continue, but strengthen, its efforts to combine the well-established function of promoting intercourse among its members, and the special branches of the science that they practise, with the newer and broader purpose of presenting genetics as one of the focal points not only of biology as a whole, but also of agriculture, medicine and the non-biological sciences; and it must do so on no narrow national basis. The developments, especially of the last few years, show that the Society is aware of these growing responsibilities. Looking back over its first hundred meetings, it may justly face the future with confidence in its ability to meet the needs of the time.

OBITUARIES

Sir Wyndham Dunstan, K.C.M.G., F.R.S.

Sir Wyndham Rowland Dunstan, director of the Imperial Institute during 1903–24, who died on April 20, aged eighty-seven, rendered great service to the British overseas countries. Educated at Bedford School and abroad, Dunstan commenced a notable scientific career as an assistant in chemistry to Prof. Th. Redwood at the School of Pharmacy of the Pharmaceutical Society and succeeded him in 1885 as professor of chemistry, a position held for ten years, during which, in 1887, he became director of the Society's new research laboratories. Simultaneously, he held the post of demonstrator in the University laboratories, Oxford (1884), and in 1885 was appointed University lecturer in chemistry in its relation to medicine. The medical bias of his work was confirmed by his appointment to the professorship of chemistry at St. Thomas's Hospital (1892–1900). Dunstan's organising ability led him to serve as secretary of the Chemical Society (1893–1903), and he was a vice-president of the Society during 1904–06. He was a member of Council of the Royal Society, and at the York meeting of the British Association in 1906 was president of the chemistry and agriculture section.

During the earlier years, Dunstan published many papers on the chemistry of drugs; but his major original work was done largely in collaboration with other workers, notably Prof. J. T. Cash, T. A. Henry, E. Goulding, F. H. Carr, H. Brown and A. E. Andrews. Much of the work, for example, that on the pharmacology of aconitine and its derivatives (with Cash), the Indian aconites, podophyllum, and *Hyoscyamus* alkaloids, was still of pharmacological and medical interest; but the research with Goulding on oximes was purely chemical in interest, and that in association with Henry on cyanogenesis in plants was a new field of much scientific and practical importance.

Sir Wyndham's real life-work, however, in which his abilities as man of affairs had full play, was done at the Imperial Institute, which was founded to investigate and display the raw materials of British overseas countries with a view to their commercial utilization. He was appointed director of the Scientific and Technical Department in 1896, and succeeded Sir Frederick Abel in the full directorship of the Institute in 1903. Possessed of clear insight, decision and driving power, he recognized promising lines of work, and, with the help of a staff devoted to the mission of the Institute, greatly extended the laboratory and intelligence services, established technical advisory committees and carried through investigations which have proved of great and lasting value to the overseas countries in developing their natural resources. Particularly valuable work was done in connexion with the much-needed extension of cotton cultivation, and Dunstan's reports on "British Cotton Cultivation" (1904 and 1908) and on "Cotton Cultivation of the World" (1910) summarized the position at those times. He was president of the International Association of Tropical Agriculture in 1910 and of the International Congress of Tropical Agriculture in 1914. In 1916 the circumstances of the War suggested an inquiry into the possibilities of increased use in Britain of certain Indian raw materials, and, at the invitation of the Secretary of State, Dunstan organised, through the Imperial Institute Committee for India, an inquiry into the subject, which resulted in a series of valuable reports. On the mineral side, Sir Wyndham's official "Report on the Coal Supply of India" was published in 1898. At his instance, and under the auspices of the Imperial Institute, Colonial mineral surveys were established in Nigeria, Nyasaland and Ceylon, which had important practical results and laid the foundations of the present Colonial geological surveys. Meanwhile, the quarterly *Bulletin of the Imperial*

Institute had been first issued in 1903, and this publication rapidly increased in importance.

Dunstan early recognized the potential educational value of the public exhibition galleries of the Imperial Institute. He secured the appointment of a scientific staff which commenced the reorganisation of the galleries, and under his direction set in train their evolution, which has advanced step by step with the economic and social development of the overseas countries. He was honorary treasurer and secretary of the Sudeley Committee, and furthered the objects of that body by appointing a guide lecturer in the galleries and encouraging conducted visits of school parties.

By official requests Dunstan visited Cyprus, Asia Minor, Ceylon, India and Newfoundland, and prepared reports on their economic development.

Sir Wyndham, together with Dr. A. Senier, was a founder and a vice-president of the Aristotelian Society. He married as his second wife Violet M. C. Hanbury Tracy, and she survives him.

S. E. CHANDLER

Sir Robert Robertson, K.B.E., F.R.S.

ROBERT ROBERTSON passed away on April 28 after a short illness which ended a very strenuous life. He was working at his researches in the Davy Faraday Laboratory almost up to the last, although he was in his eightieth year. I was first associated with him in 1900 when he was directing the laboratory of the Royal Gunpowder Factory at Waltham Abbey. In those days, almost half a century ago, ideas as to scientific control in manufacture were very modest, and the scale of remuneration was even more modest; and so this important Government factory had a staff of five or six chemists only, and their duties were many and diverse.

While at Waltham Abbey, Robertson carried out an important investigation which cleared up the then obscure question of the stabilization of guncotton, and made it possible to rationalize the method of boiling. Together with his colleague, the late William Rintoul, he worked out in his own time a process and plant for the recovery of the acetone used in the manufacture of cordite, and this was installed in the Royal Gunpowder Factory.

In 1907 he was transferred to the Research Department at Woolwich Arsenal, which had been started a few years before, largely at the instigation of Lord Haldane, as a counterpoise to the German *Zentralstelle*. There he directed the laboratories, and his work was again concerned principally with explosives. He continued accurate determinations of the calorimetry of propellants, work which proved of great value during the First World War, when it became necessary to modify the composition of cordite on account of the shortage of acetone. T.N.T. having been adopted for filling high-explosive shells, the manufacturers in Great Britain had difficulty in making enough of it, so Robertson and his staff worked out a process and erected a pilot plant, which was copied on a very large scale at the new factories at Oldbury and Queensferry.

Robertson was elected to the Royal Society in 1917 and was made a K.B.E. in 1918. In 1921 he became Government Chemist, and the range and scope of his activities were greatly extended, but he also found time and energy to carry out researches after hours. With his colleagues he investigated the infra-red spectra of ammonia and phosphine, and so was a pioneer in a branch of physical chemistry which has now become a most important means of investigating molecular structures. He also made discoveries about the structure of diamonds.

In 1931 he was one of the organisers of the chemical section of the Faraday Centenary Exhibition held at the Albert Hall, London. His acquaintance with research workers and laboratories throughout the kingdom enabled him to help bring together a most interesting lot of exhibits, and he inspired the whole of his staff with his own enthusiasm.

He retired under the age limit in 1936, but his activities did not cease, and he continued his researches, now in the Davy Faraday Laboratory; and in 1937 he was appointed director of the Salters' Institute of Industrial Chemistry. The Second World War, however, stopped these researches, as he rejoined the Research Department and took charge of the branch of it which was opened at Swansea. He also became chairman of several research committees, an activity for which he was specially fitted. After the War he went back to his laboratory bench in Albemarle Street and resumed other activities; but even his vitality was ultimately exhausted.

One of Robertson's greatest fields of work was the Royal Institution, of which he was secretary during 1926–29, and treasurer until 1946. During this time he helped to raise a very large sum for rebuilding practically the whole of the Institution and endowing its work.

Robert Robertson was born at Cupar in 1869. In 1903 he married Kathleen Stannus; he leaves a son and a daughter.

ARTHUR MARSHALL

Dr. W. J. Perry

W. J. PERRY's interest in anthropology developed while he was reading mathematics at Cambridge and had the good fortune to come into close contact with W. H. R. Rivers, when the latter was concerned with external sources of ritual and other cultural features in Melanesia and was interested in Elliot Smith's studies of archaic ritual in Egypt. Perry took up the whole question of evidence for the survival of elements of ancient Egyptian cults, beliefs and institutions in other parts of the world. For a while this was a leisure occupation, but on his invitation to join Elliot Smith at Manchester as reader in comparative religion, he was able to devote himself entirely to these questions, learning Dutch in order to make a detailed study of the Indonesian material, which he published in his first major work, "The Megalithic Culture of Indonesia" (Manchester, 1918).

Perry then proceeded on a programme of much wider scale which sought to demonstrate the diffusion of archaic cults as part of an early cultural complex throughout southern Asia, the Pacific and much of North America. His hypothesis concerning a world-wide archaic culture of predominantly Egyptian origin was set out with a wealth of detail in "The Children of the Sun" (1923), published at the time of his appointment as reader in cultural anthropology in the University of London. Perry's later work in London was increasingly hampered by severe illness, which compelled him to retire in 1939; but he made a number of supplementary studies, notably of the diffusion of agriculture, related crafts and ritual i

prehistoric Europe in "The Growth of Civilisation" (1924) and of cosmological ideas among Oceanian and other peoples in "The Primordial Ocean" (1935).

It is now generally held that Perry, like Elliot Smith with whom he worked so closely in this field, over-simplified the processes of cultural diffusion, and sometimes too readily assumed that similarities of a general or formal kind, such as the practice of similar crafts or beliefs in sky beings, were indubitable evidence of particular connexions and unitary origins. The insistence on an exclusively Egyptian source for archaic cultural features also unfortunately rendered many of his generalizations unacceptable to specialists on the early cultures of the ancient East, on which new excavations and comparative studies were accumulating a wealth of fresh material. Controversies as to Egyptian versus Sumerian or Babylonian origins often side-tracked the opportunity for collaboration between prehistorians and ethnologists in the comparative study of relations between prehistoric and living civilizations in southern Asia. But the late A. M. Hocart brought strong support for some of Perry's contentions in his comparative studies based on field research on coronation rites and other archaic ceremonials in India, Ceylon and Oceania.

Even though it be held that he claimed too much, Perry's studies established the importance of early centres of higher civilizations as factors in shaping the form and symbolism of human cult and belief over wide areas of so-called primitive culture. In the years that have followed, interest in cultural anthropology in Britain has moved strongly in other directions; but Perry will be remembered for his passionate convictions, his amazing industry, his vigour as a controversialist and not least for his warm humanity as a colleague. DARYLL FORDE

WE regret to announce the following deaths:

Dr. Norman R. Campbell, formerly of the Research Laboratories of the General Electric Co., Ltd., Wembley, on May 18, aged sixty-nine.

Mrs. Nernst, widow of Prof. Walther Nernst, For.Mem.R.S., who had been living with her daughter for the past three years in Wimbledon, Surrey, on May 4.

NEWS and VIEWS

Physical Society's Duddell Medal: Dr. E. H. Land

THE Duddell Medal for 1949 of the Physical Society was presented on June 2 to Dr. Edwin Herbert Land, inventor of the polarizing material 'Polaroid'. Though attempts had been made by previous workers to replace the costly and limited Nicol prism with dichroic substances in the form of thin laminæ, Land was the first to demonstrate the possibility of manufacturing such laminæ with sub-microscopic dichroic crystals of quinine iodosulphate correctly oriented to simulate a single crystal extended to a superficial area previously considered impossible. This method is now being superseded as the result of two stages of further development. In the first, a plastic medium is stretched to cause orientation of the micelles. It is then soaked in a solution of the iodonium compound, which is precipitated on the oriented micelles to produce a polarizing medium. In the final method, a stretched plastic medium is treated in a way which converts about 1 per cent of its bulk to a polyvinylene compound, a straight-chain polymer in which the double-bonded oxygen gives the necessary intense directional light absorption. It is claimed that this material is extremely heat-stable and very efficient. The light transmission of the single sheet is about 40 per cent, and is reduced to 0·02 per cent for two sheets in the crossed position. This is a very remarkable development of the original idea. First, Land has succeeded in eliminating the step of orienting sub-microscopic crystals of the iodonium compound; secondly, he has eliminated the compound altogether.

Land has also described an ingenious system of stereoscopic photography in which the two images are formed in two layers of polarizing crystals crossed with respect to each other and mounted on an aluminium background. Stereoscopic pictures on this principle were developed by the Polaroid Corporation under the name of 'vectographs' (*J. Opt. Soc. Amer.*, 30, 230; 1940). A further novel development described by Land is a one-step photographic process, in which the positive print can be produced in about one minute from the time the photograph is taken. In this system, the processing is carried out by feeding the negative and the printing paper between pressure rollers, the reagent being spread in the form of a viscous liquid between the negative and positive emulsions (*J. Opt. Soc. Amer.*, **37**, 61; 1947).

National Geographic Magazine and Dr. Gilbert Grosvenor

DR. GILBERT GROSVENOR, president of the National Geographic Society of Washington, D.C., was presented with a medal named after him at a ceremony on May 17, to mark his completing half a century as editor of the *National Geographic Magazine*. The *Magazine*, which is really of his making, now has a circulation of about two million copies a month. It was in 1899 that the President of the Society at the time was concerned about its official organ, which had only a trivial circulation and no funds behind it. The president in those days, who was A. Graham Bell, of telephone fame, appointed as editor of the *Magazine* a young, untried, but not untravelled, man. Since then Dr. Grosvenor has built up the reputation and circulation of this finely illustrated journal, which is known throughout the world for the excellence of its photographic illustrations and its colour plates. After five or six precarious years, the corner was turned about 1905 and the circulation steadily grew. Dr. Grosvenor has collected photographs from every corner of the globe and articles by many eminent travellers. He has also edited a series of large-scale detailed political maps issued with the *Magazine* from time to time, which have a wide circulation and use, and are notable for their accuracy. The profits of this successful publication have been largely devoted to exploration and research in various lands and seas.

Marine Biological Station at Bangor: Dr. F. Gross

Dr. Fabius Gross, who has since 1937 been lecturer in experimental zoology in the University of Edinburgh, has been appointed director of the new Marine Biological Station to be erected on the Menai Strait at Bangor. The Station, while under the immediate control of the University College of North Wales, will be managed by a committee representing the biological departments of the constituent colleges of the University of Wales, and it is likely to become a vital link in the chain of British marine stations. Apart from its function in promoting educational facilities for the students of the University and others, it will conduct and encourage research, particularly in the almost unexplored field of marine microbiology, in which botanical and zoological studies meet. It will thus be in a position to make great contributions to fundamental knowledge as well as to the practical basis of fishery research, for there can be little doubt that the food-chains which ultimately produce our fish stocks have their biological origin in the microplankton.

Dr. Gross is eminently qualified to direct the work of the Station. His zoological studies in the University of Vienna under Profs. Storch, Versluys, Przibram and Joseph, and his researches there and in the Kaiser Wilhelm Institut für Biologie in Berlin, laid the foundation for experimental investigations of feeding, swimming movements, variation and regeneration in various aquatic invertebrates. Since he came to Britain in 1933, he has turned his attention particularly to culture methods for marine organisms, and this led to the war-time research, conducted by a team partly from the Department of Zoology in the University of Edinburgh and from Millport Marine Station, into the effect upon food-chains culminating in food fishes of the addition of inorganic nutrients to restricted sea areas. His extensive experience of British marine stations has been supplemented by large-scale plankton culture at the Oceanographic Institute at Göteborg in Sweden, and he has been invited to spend the present summer in collaborative work at the Oceanographical Laboratory at Woods Hole.

Linnean Society of London

Prof. Otto Jaag, of the Federal Technical High-school, Zurich, and Dr. David Fairchild, senior agricultural explorer to the U.S. Department of Agriculture, have been elected foreign members of the Linnean Society. Prof. Jaag is distinguished for his researches in limnology, and is editor of the *Schweizerische Zeitschrift für Hydrologie*. Dr. Fairchild, now eighty years of age, is distinguished for his labours in botany in its relation to horticulture. He has introduced many thousands of useful and ornamental plants into the United States. As an author, in addition to his scientific papers, he has published five books dealing with his travels in search of plants.

Two new associates *honoris causa*, the list of whom has never exceeded twenty-five, have also been elected by the Linnean Society; they are Dr. Robert Lloyd Praeger, of Dublin, distinguished for his long and thorough work on the flora of Ireland, and for his monographs of *Sedum* and *Sempervivum*; and Dr. Arvid Hjalmar Uggla, of Uppsala, distinguished for his researches on the work, writings and life of Linnæus. Dr. Uggla is the secretary of the Svenska Linné-sällskapet and editor of that Society's *Årsskrift*; and is at present working on a complete catalogue of the known manuscripts of Linnæus.

Disk for the Isaac Newton Telescope

Sir Harold Spencer Jones, Astronomer Royal, has recently spent three months in the United States, at the invitation of many American astronomers, in the course of which he visited most of the astronomical observatories, studying programmes of work and, in particular, the design and performance of large telescopes in connexion with the design, now under consideration, of the Isaac Newton reflector. During his visit he received the gift of a 98-in. 'Pyrex' glass disk for use in this telescope. The disk, which was cast before the War by the Corning Glass Co., was originally intended for use in a large reflector for the Michigan Observatory, a project which for various reasons was later abandoned. Its cost had been defrayed from the McGregor Fund. Judge Henry Hulbert, president of the Trustees of the McGregor Fund, informed the Astronomer Royal that the Trustees had unanimously resolved to make an outright gift of the disk, together with a 26½-in. disk for a secondary mirror and the central plug from the large disk, to the Royal Greenwich Observatory, for use in the Isaac Newton telescope. This generous gift, which has been gratefully accepted, should enable the telescope to be completed and brought into use some two or three years before it would otherwise have been possible. It is a symbol of the good-will on the part of the United States towards Great Britain, which the Astronomer Royal found everywhere in the course of his visit, and of the desire for close co-operation between the astronomers of the two countries.

Gamma-emitting Materials for Industry

A preliminary announcement has already been made by the Ministry of Supply on the sale of radioactive products for industrial radiography (see *Nature*, May 7, p. 717). A paper dealing with the supply and uses of radium and radon for industry is now being distributed by the Ministry to trade associations, professional institutes and research centres. Points of interest arising from this paper are the different physical properties of radium and radon. Though they both emit gamma-rays of identical quality, the radiation of the former is constant, whereas that of the latter has a half-life period of 3·8 days. This means that the effective life of radon is a little more than a week, but this is an advantage in, say, field-work where the loss of a capsule would not be serious, nor comparatively dangerous (in contrast to radium). The disadvantage of the variable strength of radon is further offset by the fact that, for equal intensities, it is of much smaller bulk than radium; hence, for radiographs of equal resolution, radon can be used much closer to the object under test, with a corresponding reduction in exposure-time. Radium may be obtained, on hire only and after notice of two months, for periods of not less than six months; capsules containing 50 mgm. and 250 mgm. are hired for £11 5*s*. and £56 5*s*. per year, with an additional fabrication and testing charge of £20 and £100, respectively. Radon is sold outright, typical costs being £15, £20 and £25 for sources of 250, 500 and 750 millicuries, respectively. Both materials can be obtained from the Radiochemical Centre, White Lion Road, Amersham, Bucks. Gamma-radiography requires skilled personnel for the handling of materials, interpretation of radiographs, etc., and, so far as is

known, the only institution in Britain at present offering training facilities is the Kodak School of Engineering Radiography, Wealdstone, Harrow, Middlesex. Advice on the use of gamma-radiography (demonstrations are given) may be obtained from the Superintendent of Radiology Research, Ministry of Supply, Armament Research Establishment, Woolwich, London, S.E.18, and also from the Director, National Physical Laboratory, Teddington, Middlesex.

Gasteromycetes of Greenland

MORTEN LANGE has published a critical survey of the Gasteromycetes found in Greenland prior to the expedition of 1946 (*Medd. Grønland*, **147**, No. 4, pp. 32+4 pl. København: C. A. Reitzels Forlag, 1948. Kr. 2.00). Thirteen species are described in detail. Most of them have European or North American affinities, though *Calvatia tatrensis* var. *groenlandica* is practically confined to Greenland. Some earlier records are reviewed, and their naming compared with modern standards.

University of Birmingham: Appointments

THE following announcements have been recently made in the University of Birmingham. The title of reader in renal physiology has been conferred on J. A. Barclay, lecturer in physiology. *Appointments:* F. J. Dyson to be research fellow in mathematical physics; J. T. Allanson to be lecturer in electrical engineering; B. H. Pethica to be lecturer in pharmacology; R. J. Boscott to be lecturer in endocrine chemistry. *Resignations:* Dr. H. B. Whittington, lecturer in geology, on appointment as visiting lecturer in geology at Harvard University; C. D. Cruikshank, lecturer in bacteriology, on appointment as assistant pathologist at the Selly Oak Hospital; S. Harper, lecturer in metallurgy, on appointment as research fellow at the University of Chicago; M. A. Preston, assistant lecturer in mathematical physics, on appointment as assistant professor in the Department of Physics, University of Toronto; P. L. Adams, lecturer in mining, on appointment as senior lecturer in charge of mining in the University of Sydney; S. R. Cornick, a member of the physics technical staff for thirty years and steward of the Department since 1937, on appointment as chief technical officer to the Australian National University at Canberra.

Institute of Metals

THE Institute of Metals has appointed the following to be honorary corresponding members for their respective countries: *Spain*, Prof. J. Orland, professor and chief of the Department of Metallography and Strength of Materials, Instituto Católico de Artes e Industrias, Madrid; *Sweden*, Prof. A. G. E. Hultgren, professor of metallography, Tekniska Högskolan, Stockholm; *United States*, Prof. R. F. Mehl, director of the Metals Research Laboratory and head of the Department of Metallurgical Engineering, Carnegie Institute of Technology, Pittsburgh, and Dr. R. A. Wilkins, vice-president (research and development), Revere Copper and Brass, Inc., Rome, N.Y.

Royal Aeronautical Society

THE Council of the Royal Aeronautical Society for the year 1949–50 has been announced as follows: *President*, Sir John S. Buchanan; *Past Presidents*, Dr. H. Roxbee Cox, Sir Frederick Handley Page; *Vice-Presidents*, Mr. W. G. A. Perring, Mr. N. E. Rowe, Dr. H. C. Watts; *Council Members*, Lord Brabazon of Tara, Major G. P. Bulman, Mr. S. Camm, Mr. A. V. Cleaver, Dr. G. P. Douglas, Mr. G. R. Edwards, Mr. A. G. Elliott, Mr. W. S. Farren, Sir A. H. Roy Fedden, Sir Arthur Gouge, Major F. B. Halford, Prof. A. A. Hall, Mr. S. Scott Hall, Mr. J. W. F. Housego, Mr. P. G. Masefield, Mr. W. Tye, Capt. C. F. Uwins; *Honorary Librarian*, Mr. J. E. Hodgson; *Honorary Treasurer*, Capt. C. F. Uwins; *Solicitor*, Mr. L. A. Wingfield; *Secretary*, Capt. J. Laurence Pritchard.

Announcements

PROF. H. P. HIMSWORTH has been appointed by the Medical Research Council to be its secretary in succession to Sir Edward Mellanby, who retires on October 1. Dr. Himsworth is at present professor of medicine in the University of London and director of the Medical Unit at University College Hospital; he has been a member of the Council since February 1948.

THE Thomas Young Oration for 1949 of the Physical Society will be delivered by Mr. T. Smith on June 10; he will take as his subject "The Contributions of Thomas Young to Geometrical Optics, and their Application to Present-day Questions".

THE Royal Astronomical Society is arranging meetings to be held during June 30–July 2 in Manchester, in co-operation with the University of Manchester and the Manchester Astronomical Society. The programme includes a public lecture at the University, to be given by Dr. M. A. Ellison, of the Royal Observatory, Edinburgh, on "Sun, Radio and the Stars", on June 30; a visit to Jodrell Bank Experimental Station on the morning of July 1, followed by an ordinary meeting of the Royal Astronomical Society, and a dinner given by the Vice-Chancellor of the University; and a Geophysical Discussion on "Ionization in the Earth's Upper Atmosphere", to be held on July 2. Further information can be obtained from the Assistant Secretary, Royal Astronomical Society, Burlington House, London, W.1.

A CONFERENCE on "The Properties of Semi-Conducting Materials" is to be held at the University of Reading during July 11–14, 1950. The conference will be sponsored by the International Union of Physics, in co-operation with the Council of the Royal Society. It is hoped that papers will be read by prominent representatives from the United States and European countries. Details will be published later.

THE Royal Aeronautical Society announces that a scholarship to be known as the Royal Aeronautical Society Charter Scholarship, up to the value of £300 a year, will be awarded annually to assist a student wishing to undertake advanced work or study in aeronautics. Normally, the work should lead to a higher degree or postgraduate diploma, although this is not essential. Scholarships will in the first instance be awarded for a period of one year. Applications should reach the Secretary of the Society not later than June 30, stating the course it is intended to follow.

ERRATUM. In *Nature* of May 28, p. 833, it was stated that a summer school on electron microscopy will be held at the Cavendish Laboratory, Cambridge; the dates for this school are August 16–27.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

High-Energy Electron Accelerators as Pulsed Neutron Sources

In the time-of-flight method of distinguishing between neutrons of different energies, various types of pulsed neutron sources have been used. So far, however, the use of pulsed sources of high-energy electrons for generating neutrons through the (γ, n) reaction has not been reported. Experiments reported in the following letter show that the X-rays from a 3- or 4-MeV. linear accelerator will produce useful intensities of neutrons from a beryllium target.

From these results it would appear that a 10-MeV. linear accelerator would provide a suitable source.

By such means, time-of-flight measurements could be made with reasonable resolutions up to energies hitherto unobtainable.

J. D. Cockcroft

In the preceding letter, Sir John Cockcroft discusses the possibility of using high-energy electron accelerators as pulsed neutron sources. To investigate the potentialities of the method, measurements have been made on the linear electron accelerator at this Establishment[1]. An experiment was performed when the accelerator was providing 100 m.amp. peak current in a 2-μsec. pulse of electrons of energy 3·2 MeV. The electrons were absorbed in a lead target, and the resulting X-radiation was absorbed in a container about 13 in. long (in the direction of the beam) and 5 in. square. The container was filled either with heavy water or with beryllium scraps, the latter giving a density of about 0·7 gm./c.c. The neutrons produced were absorbed in manganese sulphate solution in a tank surrounding the container. The neutron production was measured by comparing the activity of the manganese solution with that produced by a 200-mgm. radium – beryllium source inserted in place of the container.

Under these conditions, calculations based on the Bethe – Heitler theory of X-ray production from electrons predict a peak neutron production in the pulse of about 3×10^{12} neutrons per sec. (for heavy-water target). The experimentally determined value was $2 \times 10^{12} \pm 25$ per cent neutrons per second, the error being due partly to uncertain calibration of the radium – beryllium source and partly to uncertainties in the comparative geometry in the main and calibration runs. The beryllium target gave a neutron production 30 per cent lower than that from the heavy water.

It is apparent, therefore, that this method holds great promise for time-of-flight measurements. With higher energy linear accelerators, measurements with good resolution up to neutron energies of 20 keV. or more should be possible. Moreover, the high electron currents available at low pulsing-rates on machines using Marx-type generators might provide neutron sources of sufficient strength to work up into the 100-keV. region. The low pulse-rate would be a disadvantage, but measurements would be possible using very long time-of-flight paths, or, alternatively, a shorter path coupled with a short pulse and a high-resolution detector.

J. C. Duckworth
A. W. Merrison

Atomic Energy Research Establishment,
Harwell, Didcot,
Berks.
April 6.

[1] *Nature*, **160**, 351 (1947).

Effect of X-Rays on the Incorporation of Carbon-14 into Desoxyribonucleic Acid

It was observed by several experimenters[1] that the incorporation of phosphorus-32 into desoxyribonucleic acid of the Jensen sarcoma, and also of normal organs, of the rat is markedly reduced by irradiation with an X-ray dose of some hundred röntgens. This result strongly suggests the explanation that the rate of formation of desoxyribonucleic acid is reduced by the effect of ionizing radiation, though the objection may be raised that it is the re-phosphorylation of the molecule during incorporation of labelled phosphate which is hampered, and not the formation or the assembly of the main constituents of the nucleic acid molecule. To avoid this objection, the effect of X-rays on the incorporation of carbon-14 into the purines of desoxyribonucleic acid in the organs of rapidly growing rats has been studied.

About five microcuries of carbon-14 incorporated with the carboxyl group of sodium acetate were injected subcutaneously to each of 91 one- to three-week-old rats. The rats were killed after the lapse of six hours, and the desoxyribonucleotides were separated from the proteins by extraction with hot trichloroacetic acid[2]; the purines obtained by hydrolysis were twice precipitated as silver salts and their radioactivity was measured. Previous to the extraction of the kidney and muscle proteins, 20 mgm. of desoxyribonucleic acid, kindly presented by Prof. Hammarsten, were added to the trichloroacetic acid extract. Half the rats were previously irradiated with a dose of 950 r., the voltage applied being 165 kV.

As shown by the figures in the accompanying table, the amount of labelled purines formed in the irradiated rats was about half the amount formed in the con-

Ratio of carbon-14 content of 1 mgm. of purine isolated from desoxyribonucleic acid of non-irradiated and irradiated rats six hours after administration of about 0·4 mgm. of labelled carbon as acetate to each of 91 one- to three-week-old rats

Organ	Ratio of C^{14} content of purine from desoxyribonucleic acid isolated from non-irradiated and irradiated rats, respectively				Ratio of C^{14} content of 1 mgm. protein from organs of non-irradiated and irradiated rats, respectively		
	Group 1	Group 2	Group 3	Group 4	Group 2	Group 3	Group 4
Intestinal mucosa	2·3	2·0	2·2	1·5	0·78	0·80	0·90
Liver	2·3	2·0	1·5	1·5		0·83	0·50
Muscles			3·1	1·8		0·91	1·0
Kidneys	1·0		3·0	3·7		1·0	1·0

Percentage of administered C^{14} incorporated in 1 mgm. intestinal mucosa

	Purine		Protein	
	min.	max.	min.	max.
Non-irradiated	$3·7 \times 10^{-5}$	$2·4 \times 10^{-4}$	$4·1 \times 10^{-4}$	$6·3 \times 10^{-4}$
Irradiated	$1·7 \times 10^{-5}$	$1·3 \times 10^{-4}$	$5·2 \times 10^{-4}$	$7·8 \times 10^{-4}$

trols, which is very similar to the reduction in the incorporation of phosphorus-32 observed earlier[1].

The rate of incorporation of carbon-14 into the proteins was not reduced by irradiation; even some increase was observed, which may be due to a decrease in the metabolic-rate produced by irradiation and leading to an increased level of carbon-14 in the liver and intestinal mucosa, corresponding to a greater incorporation of carbon-14 into the proteins of these organs. The fact that, despite the increased carbon-14 content of the proteins of the irradiated rat, we observed a markedly reduced incorporation of carbon-14 into the purines of desoxyribonucleic acid of such rats clearly indicates a reduced rate of formation of the last-mentioned compound in the irradiated animal. The observation that the rate of formation of a main constituent of cell nuclei is reduced appreciably after irradiation helps to explain the blocking effect of irradiation on cell division and the formation of anomalous mitotic products in the irradiated tissue.

In this connexion it may be of interest to recall that the hypothesis of nucleic acid starvation was recently put forward by Darlington[3], who assumes the chromosomes to vary in their behaviour and appearance according to nucleic acid supply available.

My thanks are due to Miss G. Dreyfus for very effective assistance.

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[1] A survey of earlier work has been given by Hevesy, G., *Rev. Mod. Phys.*, **17**, 102 (1945). See also Jones, H. B., personal communication (1946). Mitchell, J. S., and Holmes, B. E., Ann. Rep. British Empire Cancer Campaign, 136 (1947). Holmes, B. E., *Brit. J. Radiol.*, **20**, 450 (1947).

[2] Schneider, W. C., *J. Biol. Chem.*, **161**, 293 (1945).

[3] Darlington, C. D., Symp. Soc. Exp. Biol., **1**, 252 (Cambridge Univ. Press, 1947).

Surface Transport of Liquid Helium II

Recently, Atkins[1] has reported transport-rates in helium films which were many times greater than those observed under somewhat similar conditions by J. G. Daunt and one of us[2]. Moreover, these rates were not constant, as in our experiments, but evidently varied in a complex manner with the length of the film. Atkins used glass beakers which, in contradistinction to our original experiments, ended in a large bulb. He ascribed the phenomena observed by him as being due to the geometrical arrangement and connected with the temperature gradient in the film, supporting this suggestion by a separate experiment. Lately, de Haas and van den Berg[3] have also observed such high transfer-rates. It appears that there was no temperature gradient in their experiment, and they attribute the high rate to the complete absence of incident radiation.

A systematic study of the factors affecting the film transfer has been in progress in this Laboratory for more than two years, and it may therefore be of interest to compare our results with the above-mentioned observations. First, we have found *no* indication that high transport-rates are caused by a temperature gradient[4]. Secondly, we found that the transfer-rate of a narrow beaker was *unchanged* after a bulb had been attached to it. Thirdly, we found that the transfer-rate remained *unchanged* even when radiation was excluded completely.

It thus appears that beside the frictionless film transfer with a maximum transport-rate of about 10^{-4} cm.^{3}/cm./sec., which has consistently been observed by us in well over a hundred individual experiments, there can occur occasionally a surface flow reaching much higher rates and of more complex aspect. However, the curious fact remained that our results differ from those of Atkins and the Leyden workers, although our experimental arrangements conformed with the conditions postulated by these authors as causing high rates of flow. This seemed to indicate that the real reason for the appearance of high flow-rates has to be sought in some subtle difference in experimental technique. Observations by J. O. Closs and one of us[5] of a desorption of helium layers, probably akin to the film later discovered by Rollin and Simon[6], already showed the strong dependence of this desorption on the state of the surface. A careful analysis of all experiments in which a high transfer-rate seems to have occurred suggested to us that the real cause of this effect might be found in the condition of the solid surface carrying the transfer, and in particular in the contamination with condensed gases. In order to investigate this point, we carried out a standard transfer experiment with a cylindrical glass beaker, out of which helium flowed into the surrounding bath. The rate of transfer was again found to be in good agreement with our previous work. Then some helium gas containing a small amount of air was introduced into the cryostat, and a thin layer of solid air was deposited on the beaker. A repetition of the previous experiment showed that the character of the transfer had now completely changed. The initial transport-rate had increased about ten times, and varied with the distance of the higher level from the rim of the beaker, as observed by Atkins. Subsequent observations have shown that: (1) On depositing successive thin layers of solid air, the transfer changes gradually from the normal type to that observed in Cambridge and Leyden. (2) Beyond a certain thickness of the layer of solid air, the transfer does not increase with further deposition. (3) The layers of solid air up to the thickness which gives the saturation transport-rate are completely transparent and colourless. The appearance of still thicker layers suggests that the deposit is granular with a grain-size of the order of the wave-length of light. (4) An adsorbed layer of air deposited on the glass surface at 90° K. slightly increases the transport-rate.

These results, together with our inability to obtain high transport-rates in the earlier experiments, seem to leave no doubt that the phenomena observed in Cambridge and Leyden are entirely due to contamination of the surfaces employed and have, to some extent, lost the character of pure film transfer. While thus, in our opinion, these high transport-rates are spurious effects which may be difficult to interpret in a quantitative manner, the phenomenon is of considerable importance for cryogenic technique. We observed that after the introduction of impure helium which had deposited a layer of solid air, not only on the beaker, but also on the walls of the cryostat and the pumping tube, the evaporation of helium was greatly increased owing to the higher transfer along the walls. Clearly, the recognition of the real cause of high transport-rates and its avoidance is of particular importance for experiments below 1° K.[7]. A

detailed discussion of our experiments and their implications will be published elsewhere.

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[1] Atkins, K. R., *Nature*, **161**, 925 (1948).
[2] Daunt, J. G., and Mendelssohn, K., *Proc. Roy. Soc.*, A, **170**, 423 (1939); *Nature*, **143**, 719 (1939); *ibid.*, **157**, 839 (1946).
[3] de Haas, W. J., and van den Berg, G. J., to be published shortly; private communication.
[4] Brown, J. B., and Mendelssohn, K., to be published shortly; Brown, J. B., thesis (Oxford, 1949).
[5] Mendelssohn, K., and Closs, J. O., *Z. phys. Chem.*, B, **19**, 291 (1932).
[6] Rollin, B. V., and Simon, F., *Physica*, **6**, 219 (1939).
[7] Blaisse, B. S., Cooke, A. H., and Hull, R. A., *Physica*, **6**, 231 (1939).

Strengths of Metals

No experimental method has been suggested for recording directly the pure diffraction broadenings of X-ray reflexions; there is always an appreciable amount of broadening due to experimental conditions, and the diffraction broadening has to be disentangled from the total broadening by various procedures[1,2]. In any statement of results, therefore, it is essential that the particular procedure used should be stated, so that even if other workers think it unsatisfactory they should at least have some basis for comparison with their own results.

Wood and Rachinger do not give such experimental details in the results they have recently published[3]. In re-stating the claim that the broadening of X-ray reflexions from cold-worked metals is due to the smallness of the crystallites into which the grains are broken, they make no reference to our critical comments[4] on evidence previously given[5] in support of this claim, nor to the considerable amount of experimental work[6–9] which points to inhomogeneous internal strains as the principal cause of the broadening.

There still remains, however, the striking agreement obtained for the yield stresses of a number of metals when the values of Wood's 'limiting crystallite size' are substituted in the expression that Bragg[10] has derived theoretically. The main purpose of this present communication is to show that this agreement results also from the theory that the broadening of the reflexions is due to inhomogeneous internal stresses, the argument being as follows.

Wood's 'limiting crystallite size' t may be regarded as a parameter related to the broadening β by the relation

$$t = \lambda/\beta \cos \theta, \qquad (1)$$

where λ is the wave-length of the radiation, and θ is the Bragg angle. (In effect, this is Wood's original definition, but the unfortunate name he proposed for the parameter has been the cause of much misconception.) In Bragg's theory of the strength of metals[10], it is shown that the yield stress Y should be related to the true crystallite size t_c by the expression

$$Y = ns/t_c, \qquad (2)$$

where n is the rigidity and s is the atomic diameter. If Wood's values for t are substituted for t_c, Bragg showed that the correct order of magnitude for Y is given for a number of metals.

Combining equations (1) and (2), we have

$$Y = ns\beta \cos \theta/\lambda. \qquad (3)$$

Now, according to Stokes, Pascoe and Lipson[7], the yield stress should be related to β by the expression

$$Y = E\beta \cot \theta, \qquad (4)$$

where E is Young's modulus, which for the present purpose may be regarded as constant.

Equations (3) and (4) may be written as

$$\left.\begin{aligned} Y &= \frac{ns}{\lambda}\,\beta \cos\theta \\ \text{and } Y &= \frac{E}{\sin\theta}\,\beta \cos\theta \end{aligned}\right\} \qquad (5)$$

and it can be shown that ns/λ and $E/\sin\theta$ are approximately equal for the conditions of Wood's experiments.

The ratio of these quantities is

$$\frac{ns \sin\theta}{E\lambda} = \frac{1}{2(1+\sigma)}\,\frac{s}{\lambda} \sin\theta, \qquad (6)$$

where σ is Poisson's ratio. $\sin\theta$ is almost exactly unity, because Wood uses only the back reflexions, and, since $\sigma \simeq 0{\cdot}3$,

$$\frac{ns \sin\theta}{E\lambda} \simeq 0{\cdot}4\,\frac{s}{\lambda}. \qquad (7)$$

For most of the metals considered, $s \simeq 2{\cdot}5$ A., but λ, of course, is different for different radiations. We may, however, take the two radiations quoted by Wood[5] as examples; for cobalt $K\alpha$, $0{\cdot}4s/\lambda \simeq 0{\cdot}55$, and for molybdenum $K\alpha$, $0{\cdot}4s/\lambda \simeq 1{\cdot}4$. Thus the coefficients of equations (5) are approximately equal, and approximately correct values of Y follow from either of them.

In order to distinguish between the two equations, qualitative work is useless; quantitative results, for the variation of β with both θ and λ, are necessary, and we believe that these results have already been produced in the papers quoted in this communication.

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[1] Jones, *Proc. Roy. Soc.*, A, **166**, 16 (1938).
[2] Stokes, *Proc. Phys. Soc.*, **61**, 382 (1948).
[3] Wood and Rachinger, *Nature*, **162**, 891 (1948).
[4] Lipson and Stokes, *Nature*, **152**, 20 (1943).
[5] Wood, *Nature*, **151**, 585 (1943).
[6] Brindley, *Proc. Phys. Soc.*, **52**, 117 (1940).
[7] Stokes, Pascoe and Lipson, *Nature*, **151**, 137 (1943).
[8] Smith and Stickley, *Phys. Rev.*, **64**, 191 (1943).
[9] Megaw and Stokes, *J. Inst. Metals*, **71**, 279 (1945).
[10] Bragg, *Nature*, **149**, 511 (1942).

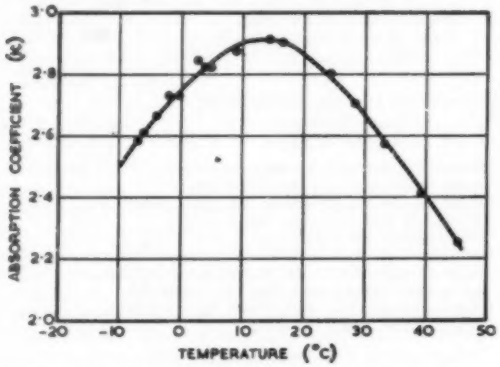
Absorption of 12·5-mm. Wave-length Electromagnetic Radiation in Supercooled Water

We have recently succeeded in measuring the absorption of radio waves of wave-length 12·5 mm. in transmission through water in the supercooled state in layers of varying thickness up to several millimetres: the lowest water temperature so far reached in this work is − 7° C.

The complex refractive index of an absorbing medium may be expressed as $(n - j\varkappa)$, and our measurements have led to a determination of the absorption coefficient $\varkappa$. It is well known that if such an absorbing medium is inserted in a wave-

guide, completely filling it over a portion of its length, the rate of attenuation of waves passing through the medium is, in general, dependent both upon $\varkappa$ and upon the refractive index n. If the lateral dimensions of the wave-guide are sufficiently great, however, it may be shown that the absorption coefficient determined by measuring the rate of attenuation in a system such as this differs by a negligible amount from the value of $\varkappa$ pertaining to a medium of infinite extent. We have used this method, the diameter of the cylindrical wave-guide concerned being 24 mm.; such a diameter is quite adequate to yield the 'infinite medium' value of $\varkappa$ at a wave-length of 12·5 mm. After transmission through the water layer, the energy was picked up in a narrow cylindrical wave-guide probe filled with polythene, of dimensions such as to restrict the propagation to that of the H_{11} mode; the probe was driven by a micrometer, so that its location in the water was accurately known.

It is very difficult to maintain liquid water in a markedly supercooled condition, no matter how pure it may be, except when in contact with quite a restricted range of materials, one of which is glass. No success was achieved in the present series of experiments until the wide wave-guide was lined inside with a thoroughly cleaned thin-walled glass tube, and until the probe wave-guide was similarly covered with a thin-walled clean glass sheath. It was established, by making comparative measurements at temperatures above 0° C., that the introduction of these pieces of glass made no difference to the measured absorption coefficient. The temperature of the water was determined by a calibrated thermocouple inserted between the outer wall of the probe wave-guide and its glass sheath. The observed values of $\varkappa$ over the temperature range − 7° C. to 46° C. are shown in the accompanying graph.



Absorption coefficient of pure water as a function of temperature and for a wave-length of 12·5 mm.

It will be seen that the absorption coefficient varies in a completely continuous manner as the temperature of the water passes through 0° C. The absorption mechanism in water, which is a pure polar liquid, is that associated with dipolar dispersion, and it has been shown[1] that a close relation exists between the relaxation time of the polar water molecule and the viscosity of water, though not quite of the simple form originally suggested by Debye[2]. Since it is known[3] that the viscosity varies continuously through 0° C. down to − 9·6° C., it is therefore not surprising that the absorption coefficient exhibits similar characteristics. A detailed description of this work will be published elsewhere later, together with an account of similar measurements at other wave-lengths.

The work described above was carried out as part of the programme of the Radio Research Board. This paper is published by permission of the Department of Scientific and Industrial Research.

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Teddington. Nov. 30.

[1] Saxton, J. A., "Meteorological Factors in Radio Wave Propagation", 306 (Physical Society, 1946).
[2] Debye, P., "Polar Molecules" (New York: The Chemical Catalog Co., Inc.).
[3] Coe, J. R., and Godfrey, T. B., *J. App. Phys.*, **15**, 625 (1944).

A Photo-electric Wool Staplemeter

The possibility of constructing a photo-electric apparatus capable of measuring the variations in fibre-length and diameter, and hence of 'tippiness' and 'break' in wool staples, has been exercising the mind of one of us (H. G.) for some time past, but only after reading a recent paper by Lord[1] were steps taken towards its realization. An experimental model, constructed by the other (R. E. B.), was ready in December 1947. In this model, the wool staple, after it has been prepared as described below, is laid lengthwise under a sheet of glass on an optically black tray (Fig. 1). The tray is capable of moving between two guides along the floor of a light-tight compartment of the apparatus. A 100-watt pearl lamp illuminates a narrow rectangular slit which is focused by means of a cylindrical lens to produce, on the tray top and at right-angles to its motion, a narrow rectangular light image approximately $\frac{1}{8}$ in. wide and 3 in. long. The scattered light from the wool is measured by means of a photo-cell which is located directly above the light image. This cell is connected to a direct-current amplifier[2] the output of which is noted on a 0–50 micro-ammeter.

The meter reading (after the zero adjustment operation has been completed) is approximately proportional to the intensity of the light falling upon the cathode of the photo-cell and is thus dependent upon the light scattered by the wool fibres. This in turn is proportional to the number of fibres, their cross-section and, to a minor degree, the nature of the scattering surface.

The aim of the preliminary investigation, on which this account is based, was to ascertain the relationship between the photo-electric reading in microamperes and the number of fibres counted at the level at which each of the readings was taken. For this purpose twenty-eight wool samples of the same count

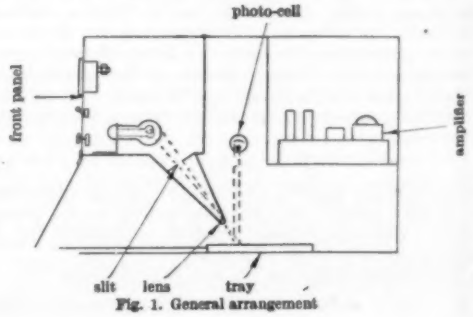

Fig. 1. General arrangement

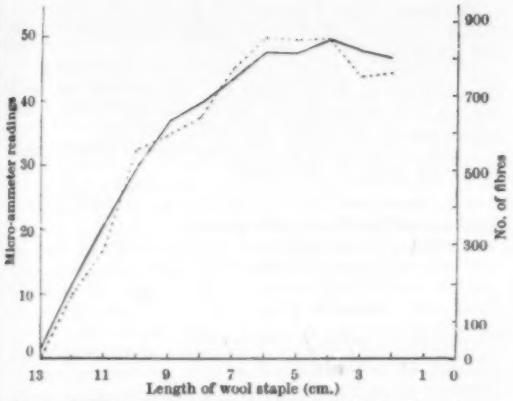

Fig. 2. Full line, number of fibres; broken line, micro-ammeter readings

(50's) and practically free of hairiness[3] were taken from New Zealand Romney Marsh unshorn (that is, not shorn as lambs) hoggets[4]. The following testing procedure has been adopted: a small sub-sample is pulled from the staple, secured in a clip at the base of the staple, and washed in benzol. When dry, it is spaced on the staplemeter clamp and teased while hanging perpendicularly. It is then transferred to the staplemeter tray, covered with the cover-glass and the micro-ammeter reading recorded at centimetre intervals. For the purpose of counting the fibres, the sub-sample is cut at centimetre intervals to correspond with the points at which the micro-ammeter readings are taken.

The twenty-eight intra-staple correlation coefficients between the micro-ammeter readings and the number of fibres thus computed proved to be statistically highly significant; their values ranged from $r = 0{\cdot}943$ to $r = 0{\cdot}994$ with 9–16 degrees of freedom. Similarly, the correlation coefficient, based on all measurements in twenty-eight samples, $r = 0{\cdot}955$ with 414 degrees of freedom, is very satisfactory, and the coefficient of regression indicates that one unit of the micro-ammeter equals twenty fibres of 50's count on the average.

Fig. 2 gives what probably is a typical example of the relationship between the micro-ammeter readings and number of fibres.

Thanks of one of the writers (H. G.) are due to Dr. E. R. Cooper, director of the Dominion Physical Laboratory, for lending the experimental model for the duration of the experiment, and to Mr. E. A. Clarke, head of the Sheep and Wool Department, Massey Agricultural College, for encouragement and helpful advice; the other writer (R. E. B.) wishes to acknowledge helpful suggestions from Dr. A. G. Bogle, of the Dominion Physical Laboratory.

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[1] Lord, E., *J. Text. Inst.*, **37**, T237 (1946).
[2] Artzt, M., *Electronics*, **18**, 112 (1945).
[3] McMahon, P. R., *J. Text. Inst.*, **28**, T340 (1937).
[4] Goot, H., *N.Z. J. Sci. and Tech.*, **27** (Sec. A), 45 (1945).

Drug-Resistance Shown by Trypanosomes Following 'Antrycide' Treatment

The control of bovine trypanosomiasis by chemotherapy has recently received a welcome stimulus owing to the discovery of the trypanocidal properties of the new drug 'Antrycide'. The original investigators (Curd and Davy, 1949 [1]) have shown its curative and prophylactic action in experimental animals against several species of trypanosomes infecting man and cattle, and at Entebbe, Uganda, we have shown[2] that the soluble sulphate salt of 'Antrycide', in doses of 3–5 mgm. per kilo, cured *Trypanosoma simiæ* infections in pigs. One pig, however, infected with *T. simiæ* and dosed with the relatively insoluble chloride salt at 2 mgm. per kilo, relapsed. A second immediate treatment with 5 mgm. per kilo 'Antrycide' sulphate failed to cure this pig, and the relapse strain was considered, therefore, to have developed drug-resistance in this short time.

This question of drug-resistance will require careful investigation in the case of *Trypanosoma congolense* and *Trypanosoma vivax* infections in cattle. Experiments at Entebbe indicate that strains of trypanosomes found in re-infected animals after the first treatment with 'Antrycide' may have considerable resistance to further treatment. This is illustrated by an experiment in which ten cattle were dosed with 2 gm. each of 'Antrycide' sulphate and were then exposed to trypanosome infection in a *Glossina pallidipes* area. Only one was alive six months later, and a strain of *T. congolense* collected from this animal and sub-inoculated into a non-infected calf at the laboratory resisted treatment with 5 mgm. per kilo 'Antrycide' sulphate; and when six mice were infected with the same strain and treated with 10 mgm. per kilo 'Antrycide' sulphate, two of them relapsed 52 days later. A field strain collected in the same area from an untreated ox was cured with 'Antrycide' sulphate at 0·5 mgm. ger kilo.

In some cases, animals re-infected some months after treatment with 'Antrycide' and re-treated with curative doses of 'Antrycide' sulphate have developed cryptic but nevertheless fatal infections. Should such cryptic infections or prolonged latent infections prove to occur frequently after 'Antrycide' treatment, an accurate estimation of the true duration of the prophylactic effect will be difficult.

We have some evidence to show that *T. vivax* also quickly develops an appreciable degree of drug-resistance after treatment with 'Antrycide'.

Treatment with 1 mgm. per kilo dimidium bromide (phenanthridinium 1553) of relapse or re-infected strains of *T. congolense* following 'Antrycide' treatment has been unsuccessful, and it appears that strains resistant to 'Antrycide' are also resistant to curative doses of dimidium bromide.

In animals which have relapsed or become re-infected after treatment with 'Antrycide', a dose of 5 mgm. per kilo will not ensure sterilization of the infection in every case and may favour the development of drug-resistance, while a dose in excess of 10 mgm. per kilo can be toxic. The toxic symptoms sometimes develop quickly, the animal losing consciousness and dying two to six hours after treatment; in other cases a severe gastro-enteritis develops forty-eight hours after treatment, and death occurs between the sixth and twelfth days.

Drug resistance may be due to the elimination of the more susceptible trypanosomes with the consequent development over several generations of

resistant strains, or possibly the drug may favour the development of resistant mutant strains. In either case, the early treatment of relapsed or re-infected cases before any marked change in the trypanosomes can be produced is obviously more likely to be successful. The limited experience we have had at Entebbe does support this contention. Repeated treatments in the field three to four times a year will, however, require careful planning, may prove expensive, and the ultimate success of such a procedure in tsetse areas still awaits proof.

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[1] Curd, F. H. S., and Davey, D. G., *Nature*, **163**, 89 (1949).
[2] Wilson, S. G., *Vet. Record* (in the press).

Influence of Streptomycin and Mineral Salts in the Action of Ribonuclease

The influence of streptomycin sulphate (Pfizer) and chloride (Ayerst) on the action of crystalline ribonuclease, prepared according to Kunitz[1], has been tested under the conditions indicated by Kunitz himself for the dosage of the activity of this enzyme.

The antibiotic was added to the fermentative system in the quantities required to attain concentrations decreasing from 1 : 1,000 to 1 : 10,000,000. As a substrate, a highly purified ribonucleic acid was used, which could be wholly precipitated by means of uranyl acetate in trichloracetic acid solution. Contrary to the observations of other authors[2], who have, in any event, worked under different conditions and employed different methods, inhibition of the action of the ribonuclease through the streptomycin was not observed.

Under the conditions in which our experiments took place, an increase of the activity of the enzyme was obtained, which at a 1 : 1,000 concentration of streptomycin reached an average increase of 50–60 per cent of the initial value. At a concentration of 1 : 10,000, the increase was 20 per cent on the average; and no change in comparison with the control could be observed by further dilution.

In order to investigate whether there is a relation between the power of streptomycin to precipitate the nucleic acids and its influence on the activity of the ribonuclease, the effect of soluble salts on such a precipitate was studied[3,4,5].

Sodium chloride and magnesium sulphate were used, and it was found that even in the absence of streptomycin, sodium chloride increases the effect of ribonuclease by about 60–65 per cent at a concentration of 0·45 per cent in the fermentative system. The effect resulting from the association of sodium chloride and streptomycin does not correspond to the addition of the effects of each substance taken separately. In fact, in a system containing streptomycin at a concentration of 1 : 1,000 and sodium chloride at a concentration of 0·45 per cent, an average increase of only 75 per cent is obtained.

Magnesium sulphate also shows an activating action on ribonuclease, greater than that of sodium chloride at the same concentration. Indeed, it produces an increase of 50–60 per cent at a concentration of 0·1 per cent, whereas at such a concentration sodium chloride is wholly ineffective.

The association of magnesium sulphate and streptomycin does not produce an effect corresponding to the addition of both actions.

The effect of other substances on the action of ribonuclease is being studied. The results of such studies will be published later, together with a detailed description of the method employed.

I wish to thank Miss Anna Spelta and Miss Emma Berti for their co-operation.

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[1] Kunitz, M., *J. Gen. Physiol.*, **24**, 15 (1940).
[2] Massart, L., Peeters, G., and Lagrain, A., *Arch. Int. Pharmacol. et Thér.*, **76**, 72 (1948).
[3] Cohen, S. S., *J. Biol. Chem.*, **168**, 511 (1947).
[4] Bracco, M., and von Euler, H., *Kemiska Arbeten*, II (May 5, 1947); (November 10, 1947); (March 10, 1948).
[5] Von Euler, H., Bracco, M., and Heller, L., *C.R. Acad. Sci. Paris*, **227**, 16 (1948).

Origin of Hyaluronidase in the Rat Testis

Duran-Reynals[1] demonstrated that mammalian testes contained a factor—the spreading factor—which was capable of increasing the permeability of the connective tissue. This observation has been confirmed by other investigators, and the factor has been identified as the enzyme hyaluronidase. Sprunt *et al.*[2] showed that hyaluronidase was present in testes from adult rats, but not in testes from infantile or cryptorchid rats. In their opinion, the formation of hyaluronidase depended on complete spermatogenesis.

Eichenberger[3], Kurzrok *et al.*[4], and Werthessen *et al.*[5] demonstrated a certain relation between the content of hyaluronidase of human semen and the number of spermatozoa, but were unable to demonstrate any complete proportionality. It was not ascertained at which stage of spermatogenesis the hyaluronidase was formed.

In order to find out at which time the hyaluronidase is formed in the testis, I have examined testes from rats of different ages, and the amount of hyaluronidase has been compared with the histological picture. The testicular tissue was extracted with water, five to ten times its own weight; the extraction took place at 4° C. and lasted twenty-four hours. Then the amount of hyaluronidase was determined by the viscosimetric technique described by Riisfeldt[6], which is a slight modification of the method of Hale[7]. The results are shown in the accompanying table.

No. of rat	Weight of one testis (mgm.)	Histological examination	Hyaluronidase content per gm. wet tissue (relative values)
28	85	Only spermatogonia	0
29	83		
38	90	Spermatogonia and few spermatocytes	(+)
39	95		
45	160	Spermatogonia, many spermatocytes and ÷ spermatozoa	++
81	385	Spermatogonia, spermatocytes and ÷ spermatozoa	+++
27	520	Spermatogonia, spermatocytes, few spermatozoa	++++
106	1250	Adult rat with normal spermatogenesis	++++

It is thus possible to demonstrate considerable amounts of hyaluronidase in rat testes before spermatogenesis is complete. In No. 28, which contained spermatogonia only, it was impossible to demonstrate the presence of hyaluronidase in spite of the fact that a very concentrated testicular extract was used in the determination. In Nos. 28 and 29, owing to the small quantity of testicular tissue, the determination of hyaluronidase was performed on all four testes at the same time, after tissue for the histological examination had been removed. The same applies to Nos. 38 and 39, where it was found that the formation of spermatocytes had commenced, and here it was possible to show the presence of hyaluronidase, although only in a very slight amount. Not until in No. 45, where there were many spermatocytes, was it possible to show the presence of larger amounts of hyaluronidase. Also in No. 81, where the number of spermatocytes was still larger, considerable amounts of hyaluronidase could be demonstrated in spite of the fact that the spermatocytes had not yet been transformed into mature spermatozoa.

In No. 27 spermatogenesis was complete; but only a few spermatozoa were found at the histological examination. The largest amount of hyaluronidase was found here; but incidentally not much more than in No. 81, where the formation of mature spermatozoa had not begun.

Thus the content of hyaluronidase seems to increase with the number of spermatocytes.

In a large number of rats it was possible to show that the formation of hyaluronidase was very pronounced in testes before the spontaneous descent had occurred.

According to the investigations presented here, there seems to be no doubt that the formation of hyaluronidase in rats occurs at an early stage of the spermatogenesis, namely, before there are any mature spermatozoa, and that it is the spermatocytes that are responsible for the formation of hyaluronidase.

A detailed account of the present work will be published elsewhere.

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[1] Duran-Reynals, F., *J. Exp. Med.*, **50**, 527 (1929); **55**, 703 (1932); **58**, 101 (1933).
[2] Sprunt, D. H., Hooker, C. W., and Raper, J. S., *Proc. Soc. Exp. Biol. and Med.*, **41**, 398 (1939).
[3] Eichenberger, E., *Gynæcologia*, **121**, 288 (1946).
[4] Kurzrok, R., Leonard, S., and Conrad, H., *Amer. J. Med.*, **1**, 491 (1946).
[5] Werthessen, N. T., Berman, S., Greenberg, B. E., and Gargill, S. L., *J. Urology*, **54**, 565 (1945).
[6] Riisfeldt, Ove, *Z. Vitamin, Hormon- und Fermentforsch.* (in the press).
[7] Hale, C. W., *Biochem. J.*, **38**, 368 (1944).

The Histochemical Test for Alkaline Phosphatase

WE should like to direct attention to the occurrence of a phenomenon of diffusion in the histochemical technique for the demonstration of alkaline phosphatase which makes precise localization of the enzyme difficult and is apt to produce errors in interpretation. With regard to such possible diffusion, two opposing views have been taken. Danielli[1], on the basis of specially designed experiments similar to, but not identical with, some of those to be reported here, has denied such diffusion (that is, of the reaction product) and declared the method as very reliable with regard to the localization of the

Fig. 1. Portion of guinea pig liver. Alkaline phosphatase reaction, 24-hr. incubation. Only a few phosphatase-positive cells in sinuses. Liver parenchyme negative. × 190

Fig. 2. Part of rabbit duodenum superimposed on guinea pig liver. Alkaline phosphatase reaction, 6-hr. incubation. Note: 'positive nuclear reaction' of the underlying liver cells with a decreasing gradient towards the top right, that is, away from the villi. × 190

enzyme. Lison[2], on the other hand, takes—at least with certain tissues—the occurrence of diffusion (that is, of enzyme) for granted and makes bad histological fixation responsible for it. There is abundant evidence in the literature in the form of photomicrographs, tabulated records, and descriptions of positive reactions given by cell constituents, especially nuclei, in the vicinity of regions of high phosphatase activity which makes the existence of diffusion as a complicating factor very likely; yet positive proof has so far been wanting. The following experiments seem to furnish such proof.

(1) Frozen or paraffin sections of alcohol-fixed portions of small intestine or renal cortex (material with high phosphatase content) were superimposed on ready-mounted paraffin sections of alcohol-fixed guinea pig liver (material which for the present purpose can be regarded as phosphatase-negative[3] (Fig. 1)). Gomori's technique with and without added magnesium ions to the substrate mixture (sodium glycero-phosphate, *p*H 9·2–9·5) and with varying incubation periods was then applied. As a result, the nuclei of the underlying liver cells gave, sometimes as early as after ½-hr. incubation, usually somewhat later, a positive reaction in regions that lay close to centres of high phosphatase activity of the superimposed section, with a gradient of diminishing 'staining' intensity away from these centres (Fig. 2). The degree of this 'positive nuclear reaction' in the underlying tissue is a function of the amount of active phosphatase in the overlying section and of the time of incubation.

(2) That diffusion also occurs within a section from foci of high phosphatase activity could be shown by excising a peripheral wedge, containing portions of Brunner's glands and adjacent muscle coats from a paraffin section of alcohol-fixed rabbit duodenum (previously tested and found to have a very high phosphatase activity), and treating this excised material simultaneously with, but on a different slide

from, the donor section according to Gomori's method. Whereas the latter—after 24-hr. incubation or even earlier—showed a widespread nuclear reaction including all the acini of Brunner's glands and most of the outer muscular coats, the excised wedge was found negative even after 72-hr. incubation.

There was no evidence of bad histological fixation. The diffusion occurs during the incubation period. Its duration is therefore of paramount importance and has to be carefully controlled for each tissue under investigation, for which purpose diffusion tests employing guinea pig liver as underlying material can be recommended.

Details of these and other experiments and a discussion of their implications will appear in the *Journal of Anatomy*.

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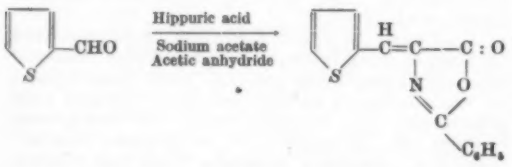
[1] Danielli, J. F., *J. Exp. Biol.*, **22**, 110 (1946).
[2] Lison, L., *Bull. Hist. app.*, No. 2, 23 (1948).
[3] Bourne, G., *Quart. J. Exp. Physiol.*, **32**, 1 (1943).

Syntheses of New Azlactones from Thiophene Aldehydes

In view of the availability of thiophene-2-aldehyde, 3-methylthiophene-2-aldehyde, 5-methylthiophene-2-aldehyde, 5-ethylthiophene-2-aldehyde, 5-propylthiophene-2-aldehyde, and 5-chlorothiophene-2-aldehyde[1], it was decided to prepare their azlactones, since these compounds serve as useful derivatives and intermediates for further syntheses.

The formation of these compounds proceeds as follows:



Using the procedure of Kropp and Decker[2], the compounds in the accompanying list were prepared.

Compound	Yield (%)	m.p. (° C.)	Analyses Calculated (%)	Found (%)
2-phenyl-4(2-thenal) 5-oxazolone[3]	68	174·5–175·5	C 65·88 H 3·53 N 5·49	C 66·1 H 3·66 N 5·69
2-phenyl-4(2-thenal 3-methyl)5-oxazolone	60	151–152	C 66·91 H 4·09 N 5·20	C 66·87 H 4·07 N 5·51
2-phenyl-4(2-thenal 5-methyl)5-oxazolone	58	152–153	C 66·91 H 4·09 N 5·20	C 67·00 H 3·94 N 5·40
2-phenyl-4(2-thenal 5-propyl)5-oxazolone	60	97–98·5	C 68·69 H 5·05 N 4·71	C 68·80 H 5·28 N 4·90
2-phenyl-4(2-thenal 5-ethyl)5-oxazolone	60	107·5–109	C 67·84 H 4·59 N 4·94	C 68·02 H 4·48 N 4·94
2-phenyl-4(2-thenal 5-chloro)5-oxazolone	61	182·5–183·5	C 58·03 H 2·76 N 4·83	C 58·40 H 2·74 N 5·19

All melting points are uncorrected.

Our studies include an extension of the reactions of unsaturated azlactones to the thiophene series as well as other syntheses of the rhodanine and hydantoin derivatives of thiophene aldehydes.

This investigation was carried out with the aid of a grant from the Office of Naval Research, and full details of it will be presented in due course elsewhere.

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[1] King and Nord, *J. Org. Chem.*, **13**, 635 (1948); **14**, 148 (1949).
[2] Kropp and Decker, *Ber.*, **42**, 1184 (1909).
[3] Barger and Easson, *J. Chem. Soc.*, 2100 (1938).

Thermal Decomposition of Hydrogen Peroxide in the Vapour Phase

Baker and Ouellet[1] reported that when they boiled 98 per cent hydrogen peroxide solution at 100° C. and passed the vapour at pressures varying between 3 and 18 cm. of mercury through a wide 'Pyrex' tube heated to 335° C., they got no explosion even when they passed an electric discharge along the tube or caused a piece of cotton to burn in the gas. We find that, in a 3-cm. diameter 'Pyrex' tube at 100° C., thermal decomposition flames and explosions are very readily initiated by a hot wire or a spark when the pressure is about 2 cm. of mercury or higher. At atmospheric pressure the explosion is very violent and is initiated by catalytic spots on imperfectly cleaned glass. The minimum temperature to which a wire must be heated to cause immediate ignition of the gas at atmospheric pressure has been roughly determined to be about 600° C. Thus, hydrogen peroxide seems similar in its behaviour in the vapour phase to the di-alkyl peroxides with which Harris[2] obtained thermal explosions. These compounds, unlike hydrogen peroxide, decompose entirely homogeneously below 170° C., the temperature around which the explosions occur. The results of the latest workers with hydrogen peroxide are not in complete agreement on this point. Giguère[3] reports no slow thermal decomposition at temperatures as high as 420° C.; but Mackenzie and Ritchie[4] are of the opinion that their results may indicate an appreciable gas-phase reaction in the upper part of their temperature range (namely, 82–137° C.).

It has been found possible to stabilize the flame at pressures as low as 4 cm. of mercury on a jet. It is then clearly visible in a darkened room. An interesting effect is produced by igniting the vapour above rapidly boiling liquid. The flame comes to rest on the surface, and the liquid then boils away steadily but much more quickly than before, going straight to the decomposition products. When resting on the liquid, the flame becomes less easily visible, probably because its temperature is lowered by the presence of a fine spray of the liquid.

The vapour explosion shows no tendency to pass to the liquid phase even when that is 99·8 per cent hydrogen peroxide boiling at atmospheric pressure (*c.* 150° C.). It is clear that most of the explosions said to result from heating concentrated hydrogen peroxide solutions to 150° C. occur in the vapour, and not the liquid phase as is generally implied[5].

It is proposed to continue to study this interesting reaction in greater detail, and to publish a full report elsewhere.

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[1] Baker and Ouellet, *Can. J. Res.*, **23** B, 167 (1945).
[2] Harris, *Proc. Roy. Soc.*, A, **175**, 254 (1940).
[3] Giguère, *Can. J. Res.*, **25** B, 135 (1947).
[4] Mackenzie and Ritchie, *Proc. Roy. Soc.*, A, **185**, 207 (1946).
[5] Midard, *C.R. Acad. Sci., Paris*, **222**, 1491 (1946).

Vibrations of an Infinitely Long Chain of CH_2-Groups and the Infra-red Spectrum of Polythene

The vibrations of an infinitely long chain of CH_2-groups have been calculated using a valence and angle force potential. It is assumed that the carbon atoms form a zigzag line in the x,y-plane, from which the two C—H linkages branch off symmetrically with respect to this plane, with the x-axis as molecular axis. This array can be considered as a crystal lattice the elementary cell of which consists of two CH_2-groups (six particles in the cell) resulting in eighteen vibrations of the elementary cell. The potential function V has the form:

$$2V = f_C \sum_i l_i^2 + f_H \sum_i (l_i'^2 + l_i''^2) + b^2\varphi_H \sum_i \beta_i^2 + a^2\varphi_C \sum_i \lambda_i^2 + ab\,\varphi_{CH}\{\sum_i(\delta_i'^2 + \delta_i''^2) + \sum_i(\varepsilon_i'^2 + \varepsilon_i''^2)\} + 2\,ab\,\sin\frac{\theta}{2}\,\tau\sum_i \Psi_i^2.$$

$$(\lambda_i = \beta_i - \delta_i' - \delta_i'' + \varepsilon_i' + \varepsilon_i''),$$

where l_i is stretching of C_i-C_{i+1} linkages; l_i' and l_i'' are stretching of two C—H linkages attached to C_i; λ_i is change of the angle $C_{i-1}-C_i-C_{i+1}$; β_i is change of the angle $H_i'-C_i-H_i''$; δ_i', δ_i'' are changes of the angle $C_{i-1}-C_i-H_i$; ε_i' and ε_i'' are changes of the angle $H_i-C_i-C_{i+1}$; Ψ_i is angle of twist of C—C linkages produced by a rotation of the two CH_2-groups at the ends of the bond around it; a is the equilibrium distance of the carbon atoms, b of the C—H linkages and θ the tetrahedral angle; f_C, f_H, etc., are the force constants associated with these movements.

The vibrations can be split up into two groups, symmetric and antisymmetric with respect to the x, y-plane. There are five frequency branches in the symmetric group and four branches in the antisymmetric group. The eighteen vibrations (corresponding to the phase differences 0 and π) have been evaluated as functions of the force constants and interatomic distances, and the dipole moments associated with them calculated on the assumption that only the C—H linkages carry a dipole moment. Five frequencies turn out to be zero (improper vibrations), and of the remaining thirteen only five are infra-red active. The inactivity of the other vibrations is due to the inner symmetry of the elementary cell (symmetry group $S_2(i)$).

An attempt has been made to fit these vibrations to the observed infra-red spectrum of polythene[1] (molecular weight 13,000); the results of the calculations are compared in the accompanying table with Thompson and Torkington's[1] and Fox and Martin's[2] observations.

Infra-red spectrum of C_nH_{2n}

Symmetry class	Frequencies in wave numbers			Relative intensities	
	Calc.	Obs.		Calc.	Obs.
A_g	ν_2 1090 cm.$^{-1}$	1080 cm.$^{-1}$	[1]	0	3·5
	ν_2 2880	2853	[2]	0	0·9
	ν_4 1560	—		0	—
	ν_5 890	890	[1]	0	2·0
	ν_6 1617	1640	[1]	0	1·0
A_u	ν_8 717	725	[1]	100 M_z	100 σ [3,4]
	ν_9 2960	2960	[2]	0·7 M_z	0·6
B_g	ν_{12} 1710	1710	[1]	0	0·9
	ν_{13} 1490	1380 ?	[1]	0	16 π [4]
	ν_{14} 2980	—		0	—
B_u	ν_{16} 1307	1310	[1]	10 M_x	0·8
	ν_{17} 2884	2925	[2]	1·7 M_y	0·5
	ν_{18} 1460	1460	[1]	65 M_y	27 σ [3,4]

The observed intensities refer to the absorption coefficient at maximum absorption; the calculated intensities are proportional to $n^2e_H^2$, where n is the number of CH_2-groups in the molecule and e_H the effective charge on the CH-dipole. M_x, M_y and M_z are the non-vanishing components of the dipole moment; the observed polarization is indicated by π and σ. π and σ mean that the intensity of the band is stronger when the incident electric vector is parallel or perpendicular to the molecular axis (x-axis). The inactive bands are, with two exceptions, weakly active, possibly on account of the two CH_2-groups at the ends of the molecule. Besides, any folding of the chain would destroy the $S_2(i)$ symmetry, that is, alter the selection rules. The spectra of cracked polythenes observed by Thompson and Torkington[1] seem to show that the case of molecular weight 7100 ($n \sim 500$) must still be treated as a finite molecule, whereas the periodic structure is fully established for a molecular weight of 13,000 ($n \sim 900$).

It is proposed to extend this treatment to more complicated polymers. A detailed report of the calculations will be published shortly.

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[1] Thompson, H. W., and Torkington, P., *Proc. Roy. Soc.*, A, **184**, 3 (1945).
[2] Fox, J. J., and Martin, A. E., *Proc. Roy. Soc.*, A, **175**, 208 (1940).
[3] Sutherland, G. B. B. M., and Vallance Jones, A., *Nature*, **160**, 567 (1947).
[4] Elliott, A., Ambrose, E. J., and Temple, R. B., *J. Chem. Phys.*, **16**, 877 (1948).

Metallic Oxides as Barrier Treatments for Prevention of Attack by Light on Cellulose

Although the literature contains evidence of sporadic attempts to investigate various types of barrier treatments on cellulose for the prevention of attack by light[1,2,3], no systematic work would appear to have been carried out to date on the subject. The evidence is often conflicting, as in the case of iron compounds[1,2], and in any event the mechanism of protective action of such diverse barriers as have been studied is not clear. In the course of a wider investigation on the elucidation of the mechanism of attack by light on cellulose, which is in progress in this Laboratory, it was considered of immediate practical importance to study on systematic lines the influence of certain metallic oxides deposited on

cotton fabric in protecting the latter against actinic attack. While the details of the technique of investigation and the results obtained, particularly on the chemical aspect of protection/deterioration of cellulose, are reserved for a future publication, it is the object of the present note to direct attention to the remarkable effect of manganese (as oxide) in inhibiting actinic deterioration.

The metals investigated were chromium, copper, iron, manganese, tin, titanium and aluminium. Three different concentrations of the metals, approximately 0·05, 0·5 and 1 per cent on the weight of fabric, were studied. Dosootie, a fabric of Indian tentage, was used. The metals were deposited as their oxides on the fabric by a double-bath process involving initial treatment in a soluble salt solution and subsequent decomposition with aqueous solution of alkali. The treated fabrics and untreated control pieces were exposed during hours of sunshine at Kanpur (lat. 26° 26′ N., long. 80° 22′ E.) for a total period of 2,400 hours. Samples were drawn according to a randomized plan initially and at intervals of 400 hours. Bursting-strength determinations were carried out at each sampling.

The results showed that manganese (0·56 and 1·3 per cent) on fabrics retards in a remarkable manner the course of actinic degradation; there is possibly a critical concentration of manganese above which only the protective effect is apparent. Although iron and aluminium in the higher concentrations (0·84 and 0·45 per cent respectively) show some protective effect in the very early stages of exposure, they are not useful. Fabrics containing chromium in the higher concentrations (0·8 per cent) generally follow the pattern of the control in the rate of degradation. Copper, tin and titanium accelerate degradation, the effect being most marked in the case of copper and titanium.

While the result with copper is not surprising, the behaviour of manganese in inhibiting actinic degradation has considerable practical possibilities. Confirmatory experiments on this are in progress.

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[1] Wagner, Webber and Siu, *Arch. Biochem.*, **12**, 35 (1947).
[2] Ramsbotham, J. E., "The Fire-proofing of Fabrics" (H.M. Stationery Office, 1947).
[3] Cunliffe, P. W., *Shirley Inst. Mem.*, **2**, 244 (1923).

Preparation of Ferric Succinate Jellies

It is well known that a neutral solution of succinic acid gives a brownish-red precipitate of ferric succinate with a ferric chloride solution. Handl[1] obtained brownish-red crystals of ferric succinate by treating a ferric chloride solution with a solution of sodium succinate. We have now succeeded in preparing ferric succinate jellies.

The jellies have been obtained by the metathetical reactions between ferric chloride and sodium succinate. A ferric chloride solution containing 17·54 gm. of ferric oxide per litre and a 5 per cent solution of sodium succinate were found to give the best jellies. To 4 c.c. of the ferric chloride solution were added different amounts of the sodium succinate solution. The total volume was kept at 6 c.c. in each case. The mixtures were shaken for about thirty seconds and then allowed to stand in a bath maintained at 25° C. The influence of the varying amounts of sodium succinate on the time of setting of the jellies was recorded.

Amount of sodium succinate (c.c.)	Time of setting (hr.)
2·0	1
1·9	2
1·8	4
1·7	6
1·6	9
1·4	15
1·2	24
1·0	36

These jellies, like the jellies of ferric phosphate and ferric arsenate investigated by Prakash[2], and of thorium borate investigated by Mushran[3], are transparent, firm and perfectly stable. It is, however, interesting to note that whereas the other transparent jellies of ferric salts have been obtained by the dialysis of their sols and subsequent coagulation with suitable electrolytes, ferric succinate is the only jelly of iron so far known which has been obtained in a perfectly transparent state by the metathetical process. These jellies do not exhibit any syneresis and maintain their transparency even when kept for a long time. They set more readily at higher temperatures than at low, but lose their uniformity of texture and become opaque when allowed to set at high temperatures.

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[1] Handl, "Jahresbericht über die Fortschritte der Chemie", 279 (1859).
[2] Prakash and Dhar, *J. Ind. Chem. Soc.*, **6**, 391 (1929).
[3] Mushran, *Nature*, **158**, 95 (1946).

Genetical Differences in Taste Sensitivity to Phenylthiourea and to Anti-thyroid Substances

Fox[1] first observed that people differed in their ability to taste phenylthiourea, and it was found (Blakeslee and Salmon[2], Blakeslee[3], Snyder[4,5]) that these differences were genetically determined. The distribution of taste thresholds to this substance in all populations so far studied has been found to be bimodal. Familial investigations indicate that the two classes of individuals, 'tasters' and 'non-tasters', that is, those relatively sensitive and those relatively insensitive to phenylthiourea, differ in respect of a single gene pair, the 'tasters' being homozygous or heterozygous for the dominant allele, the 'non-tasters' homozygous for the recessive allele. Between one quarter and one third of all individuals tested in various populations appear to fall into the recessive class. Fisher, Huxley and Ford[6] have described observations which suggest that similar differences may exist among anthropoid apes. They have pointed out that this implies the existence of a stable, balanced polymorphism, and that, for such a system to occur, the heterozygotes should have had some selective advantage over the two types of homozygotes.

The taste sensitivity to phenylthiourea has been found to show only slight correlation or no correlation at all with taste sensitivity to some other bitter sub-

stances, such as quinine[7,8,9], strychnine[7], picric acid[7,9] and diphenylguanidine[10]. On the other hand, Fox[1] observed that 'non-tasters' for phenylthiourea appeared also to be insensitive to several closely related substances, such as *para*-ethoxyphenylthiocarbamide, symmetrical diphenylthiocarbamide, dibenzylthiocarbamide and dicrotylthiocarbamide, whereas 'tasters' for phenylthiourea were sensitive to them. In this work he used only the powder for testing purposes, and did not determine threshold values. He was not able to detect any differences by this method for one closely related substance, thiourea, which he found had a "nauseating taste to both tasters and non-tasters". Riddell and Wybar[11] found that thiouracil tablets were markedly bitter to phenylthiourea tasters and not bitter to phenylthiourea non-tasters. Hopkins[12] found that 2-mercapto-5,5 dimethyloxazoline, a substance which he extracted from the seeds of a cruciferous weed *Conringia orientalis*, was also bitter to phenylthiourea tasters and not bitter to phenylthiourea non-tasters.

y	<1	1	2	3	4	5	6	7	8	9	10	11	12	13
8	—	—	—	—	—	—	—	—	1	—	—	4	1	—
7	—	—	—	—	—	—	—	—	—	—	2	1	1	1
6	—	—	—	—	—	—	—	—	2	3	5	—	—	—
5	—	—	—	—	—	—	—	—	1	2	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	1	—	—	—
3	1	2	—	—	2	—	1	—	—	—	—	—	—	—
2	1	—	—	1	1	—	—	—	—	—	—	—	—	—
1	—	1	1	1	—	—	—	—	—	—	—	—	—	—

x

Thresholds for phenylthiourea and thiourea for 37 individuals. The abscissa denotes threshold values for phenylthiourea in units of $0{\cdot}26 \times (\tfrac{1}{2})^x$ per cent. The ordinate denotes threshold values for thiourea in units of $(\tfrac{1}{2})^y$ per cent. The two groups of 'tasters' and 'non-tasters' are the same for both substances.

Recently, we have developed a method of measuring taste thresholds which aims at determining the lowest concentration of the substance at which an individual can accurately discriminate the solution from water. Using this method, we have tested a number of individuals with phenylthiourea, thiourea, symmetrical diphenylthiourea, thioglyoxaline, thiouracil, phenylurea, uracil and urea. We found that there is a high correlation between taste sensitivity for phenylthiourea, symmetrical diphenylthiourea, thiourea, thioglyoxaline and thiouracil. There was no such correlation between sensitivity to these substances and to urea, phenylurea and uracil. (The accompanying table illustrates the relationship found between sensitivity to phenylthiourea and thiourea.) Thus, substances so far tested, to which the genetically distinct types of individuals respond differently, all contain the grouping

$$=N-\overset{\overset{\|}{S}}{C}-$$

This grouping has been found to be of importance in quite another sphere of biological research.

Chesny, Clawson and Webster[13,14] observed the development of goitre and a decrease in metabolic-rate in rabbits fed exclusively on cabbage. This led to experiments with the *iso*-thiocyanates, important chemical constituents of cabbage, and eventually with thiourea and thiouracil. Thiourea and thiouracil have been found to interfere with the function of the thyroid gland and to reduce the formation of thyroxine. Many closely related substances have been examined and found to possess the same anti-thyroid activity in various degrees. Some of these substances, for example, thiouracil, methylthiouracil, propylthiouracil, are now commonly used in the treatment of thyrotoxicosis. Astwood, Bissell and Hughes[15] investigated two hundred and twenty different substances and found that two types of chemical structure were associated with antithyroid activity. The more active class possessed the thiocarbonamide grouping. Among the substances tested and found to have antithyroid activity was 2-mercapto-5,5 dimethyloxalidine.

Differences in taste sensitivity may reflect metabolic differences between individuals with respect to these substances. Such metabolic differences could presumably affect the biological fitness of the three genotypes, and hence perhaps lead to a balanced polymorphism.

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[1] Fox, A. L., *Proc. U.S. Nat. Acad. Sci.*, **18**, 115 (1932).
[2] Blakeslee, A. F., and Salmon, M. R., *Eug. News*, **16**, 105 (1931).
[3] Blakeslee, A. F., *Proc. U.S. Nat. Acad. Sci.*, **18**, 120 (1932).
[4] Snyder, L. H., *Science*, **74**, 151 (1931).
[5] Snyder, L. H., *Ohio J. Sci.*, **32**, 436 (1932).
[6] Fisher, R. A., Ford, E. B., and Huxley, J., *Nature*, **144**, 750 (1939).
[7] Salmon, T. N., and Blakeslee, A. F., *Proc. U.S. Nat. Acad. Sci.*, **21**, 78 (1935).
[8] Falconer, D. S., *Ann. Eug.*, **13**, 211 (1947).
[9] v. Skramlik, E., *Jena Z. Med. Nat.*, **76**, 50 (1943).
[10] Snyder, L. H., and Davidson, D. F., *Eug. News*, **22**, 1 (1937).
[11] Riddell, W. J. B., and Wybar, K. C., *Nature*, **154**, 669 (1944).
[12] Hopkins, C. Y., *Canad. J. Res.*, B, **16**, 341 (1938); **20**, 268 (1942).
[13] Chesney, A. M., Clawson, T. A., and Webster, B., *Bull. Johns Hopkins Hosp.*, **43**, 261 (1928).
[14] Webster, B., and Chesney, A. M., *Amer. J. Path.*, **6**, 275 (1930).
[15] Astwood, E. B., Bissel, A., and Hughes, A. M., *Endocrinology*, **37**, 456 (1945).

Aerobic Metabolism in Nematode Parasites of the Alimentary Tract

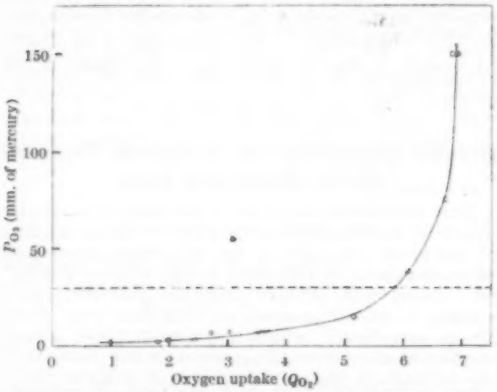
The conflicting evidence concerning the relative importance of aerobic mechanisms in the metabolism of nematode parasites of the alimentary tract may be summarized by reference to the work of Davey[1], who found that oxygen prolonged the survival of certain intestinal parasites *in vitro*, and that of von Brand and Weise[2], who found oxygen to be absent, or present only in small amounts, in the contents of the alimentary tracts of several host animals.

The problem has been re-examined in the following way: (1) Oxygen tensions in gut fluids close to the mucosa of host animals have been determined in anæsthetized animals with intact alimentary circulations using the electrometric method of Brink and Davies[3]. It was considered that such a method, rather than the analysis of relatively large samples from the intestines of dead animals, would give a more exact indication of the oxygen available to small parasites which probably live close to the mucosa (Porter[4]). (2) The ability of certain nematode parasites of the alimentary tract to utilize oxygen at low partial pressures was next examined. Oxygen uptake was determined by the indirect method of Warburg, using a saline medium in vessels of about 4-ml. capacity. The shaking-rate was adequate, and the oxygen uptake, at a given oxygen tension, was

directly proportional to the amount of respiring tissue (50–100 mgm. wet weight).

The parasites examined were *Nippostrongylus muris* from the rat small intestine, *Hæmonchus contortus* from the sheep abomasum and *Nematodirus filicollis* and *N. spathiger* from the sheep small intestine. These parasites were selected because it was thought that they might be small enough to allow oxygen to penetrate to their central tissues even without the aid of a circulatory system, and because they all contain specific hæmoglobins which have low loading tensions, particularly in the case of the sheep parasites (Rogers, unpublished).

Oxygen concentrations close to the mucosa in the small intestine of the rat ('Nembutal' anæsthesia) and in the sheep small intestine and abomasum ('Kemithal' anæsthesia) were determined. Precautions were taken to avoid, as much as possible, the introduction of air into the alimentary tract when electrodes were inserted. In the region of the intestine of the rat where *Nippostrongylus muris* was found, the oxygen tension varied from 19 to 30 (average 24) mm. of mercury in eight animals. Only two sheep were examined; but measurements were taken at four points along the intestine of each animal. Oxygen tensions, as in the rat, were generally higher nearer the pylorus and varied from 12 to 4 (average 6·5) mm. of mercury. The regions normally occupied by the *Nematodirus* spp. showed the lower range of oxygen concentrations. Oxygen tensions on the abomasal mucosa appeared to be higher than in the sheep intestine, but as the technique for handling the abomasum was not satisfactory, these results can only be accepted with reserve.



Oxygen uptake of *Nippostrongylus muris* at different partial pressures of oxygen. The broken line indicates the upper limit of the oxygen concentrations found in the small intestine of the rat host in the region normally inhabited by the parasites

The oxygen consumption of the parasites was found to vary with the oxygen tensions. Results obtained with *Nippostrongylus muris* are shown in the accompanying graph. When the results were treated according to the relationship:

$$A = \frac{P}{K_1 + K_2 P},$$

where A represents the oxygen uptake (ml./hr./gm. dry wt.), P represents the oxygen pressure (mm. of mercury) and K_1 and K_2 are constants, P/A plotted against P gave a straight line with a K_1, the intercept, of 1·2, and a K_2, the slope, of 0·14.

Nematodirus spp. and *Hæmonchus contortus* gave results similar to those obtained with *Nippostrongylus muris*, though both parasites showed less ability to utilize oxygen at low partial pressures. Thus, with oxygen at a pressure of 5 mm. of mercury, *Nippostrongylus muris* showed an oxygen consumption of 40 per cent of the maximum rate, and *Nematodirus* spp. and *Hæmonchus contortus* respired at 25 and 12 per cent of their maximum rates respectively. The results indicate that *in vivo* oxygen tensions may be such that the respiratory-rate may reach 80 per cent of the maximum *in vitro* rate in the case of *Nippostrongylus muris* and 40 per cent in the case of *Nematodirus* spp. *Hæmonchus contortus* probably respires at a relatively lower rate than the intestinal parasites.

It should be emphasized that the above figures are given relative to the maximum rate of oxygen uptake *in vitro*. Even at low oxygen tensions, the parasites make intensely active movements *in vitro* at 37° C.: this activity almost certainly does not occur *in vivo*, in which case the maximum oxygen uptake *in vivo* may be much less than *in vitro*, and respiration *in vivo* may reach a relatively higher rate than the figures given here really indicate.

It may be concluded that aerobic mechanisms play an important part in the metabolism of small nematode parasites of the alimentary tract, particularly in the case of *Nippostrongylus muris* and *Nematodirus* spp.

The results of the work, which was carried out as part of the research programme of the Division of Animal Health and Production, Council for Scientific and Industrial Research, will be published in full elsewhere.

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Nov. 8.

[1] Davey, D. G., *J. Exp. Biol.*, **15**, 217 (1938).
[2] v. Brand, Th., and Weise, W., *Z. vergl. Physiol.*, **18**, 339 (1932).
[3] Brink, F., and Davies, P. W., *Rev. Sci. Instr.*, **13**, 524 (1942).
[4] Porter, D. A., *J. Parasit.*, **21**, 226 (1935).

Lymnæa stagnalis as an Intermediate Host of *Fasciola hepatica*

The possibility of British species of *Lymnæa*, other than *L. truncatula*, acting as vectors of *Fasciola hepatica* has remained a moot point since Thomas[1], in 1883, observed the miracidia to penetrate young specimens of *L. pereger*. The observation of Nöller and Sprehn[2], in 1924, added to the uncertainty, when by dissection of a young specimen of *L. stagnalis* they actually secured cercariæ that were sufficiently far developed to show the lateral glands. As a result of experiments recently carried out at Weybridge, it can now be stated with certainty that *F. hepatica* is capable of completing its development in *L. stagnalis* with the ultimate emergence of cercariæ, which encyst and are capable of producing fluke infestation in mammals.

The snails used in these experiments were freshly hatched second-generation laboratory-reared specimens, maintained under conditions that would exclude all possibility of unwanted infection, or the ingress of any other species of snail. They were ex-

posed to massive infestation by the miracidia of *F. hepatica*, freshly hatched from laboratory incubated eggs, the technique of snail infection being the same as that employed at the Laboratory for the infection of *L. truncatula*.

Examination of 101 of the experimental snails showed that 13 had become infected. Ten of these 13 were dissected before the developmental cycle of the fluke had been completed, two died soon after commencing to shed cercariæ; but from the third, 99 perfect cercariæ emerged, including 86 which left the snail within a 24-hr. period, 113 days after the date of infection. Four of these cercariæ were pipetted into the mouth of a rabbit, and in six weeks time one half-grown specimen of *F. hepatica* was recovered from the bile ducts.

Attempts to infect adult specimens of *L. stagnalis* have so far failed, and it is interesting to note that the report of Nöller and Sprehn[2] of partial success with that species, and the report of Thomas[1] of partial success with *L. pereger*, also referred to young specimens. It appears, therefore, that immature specimens are more susceptible than are adults.

Although of biological interest, this observation may have little significance from the veterinary point of view on account of the definitely aquatic habit of *L. stagnalis*, which appears to be confined to permanent water. It shows the possibility, however, of the maintenance of liver-fluke infestation in environments from which *L. truncatula* is absent, and suggests that immature specimens of yet other species of *Lymnæa* may also serve as vectors. The investigation of these possibilities is proceeding at Weybridge, and partial development of the fluke in *L. pereger* and *L. palustris* has already been observed.

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[1] Thomas, A. P., *J. Roy. Agric. Soc.*, ii, **19**, 276 (1883).
[2] Nöller, W., and Sprehn, K., *Berl. tierargtl. Wschr.*, **40**, 369 (192

Symptomatology of Virus Diseases Induced in Cacao by '2–4,D' Treatment

During the treatment with commercial '2–4,D' emulsions of small blocks of cacao (*Theobroma cacao*) for weeding, in Venezuela, a peculiar phenomenon was observed incidentally. Basal shoots ('chupons') react to the treatment with distortion and malformation, then dropping of young leaves. A few scattered leaves developed from buds were wrinkled, more or less curled up to rolled, hardened and rugose or smooth, and more or less ruffled. The size of leaves was frequently reduced, chiefly as regards width in relation to the length. A number of leaves were mottled or even chlorotic, but also vein-banded or with red-stained veins; others were healthy and normal.

The symptomatology is that of one or two or sometimes even more virus diseases, in the same tree, as previously described in Trinidad by Posnette[1], and in the Dominican Republic and Colombia by Ciferri[2]. Of course, the next new flush of foliage consisted of healthy leaves.

The same effect induced by treatments with '2–4,D' has been observed in Italy on the vine (*Vitis vinifera*) by Baldacci and Topi[3], with symptomatology resembling 'courtnoué' or 'roncet'.

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Dec. 14.

[1] Posnette, F. A., *Trop. Agric.*, **21** (6), 105 (1944). Posnette, F. A., and Palma, M., *ibid.*, (7) 130 (1944).
[2] Ciferri, R., *Bol. Est. Nac. Agr. Moca*, B, Bot., **16**, 108 (1929); *Rev. Fac. Nac. Agron. Medellin*, **8** (29/30), 79 (1948).
[3] Baldacci, E., and Topi, M. (in the press).

Nutritional Requirements of *Drosophila*

Since our earlier publication[1], the following additional information has been obtained about the nutritional requirements of *Drosophila melanogaster*. Addition of 25 γ thymine per culture to the basal medium leads to accelerated development, pupæ being formed seven days after egg-laying. This represents a decrease in developmental time of one day at least over controls without thymine. Further acceleration can be obtained by addition of 20 mgm. of a yeast fraction prepared by treating yeast with hot 2 per cent sodium bicarbonate, filtering, rendering slightly acid with hydrochloric acid, and precipitating the fraction with an excess of ethanol. Pupation can then ensue five days after oviposition. That the active fraction is not nucleic acid as supplied commercially is shown by the fact that parallel cultures without the fraction, but containing additional nucleic acid, do not show the same effect.

There is also some evidence that the basal medium as constituted at present may be deficient in some specific amino-acid. This is suggested by the fact that the addition of globin (prepared from hæmoglobin by hydrochloric acid hydrolysis and salting out) gave pupæ of much larger size than those obtained from the normal basal medium. This possibility is now being followed up.

For convenience, the composition of the basal medium as now constituted is given below.

	gm.		gamma
Casein (vitamin-free)	0·06	Aneurin hydrochloride	4
Gelatin (reprecipitated)	0·045	Riboflavine	6
dl-Tryptophane	0·005	Nicotinic acid	12
Ergosterol	0·005	Pyridoxin	12
Cholesterol	0·005	Biotin	0·2
Dextrose	0·1	Calcium-*d*-pantothenate	1500
Agar	0·1	Thymine	25
Yeast nucleic acid	0·0034	Inositol	12
Tatum salt mixture (1936)	0·006	Folic acid	2
Water to 5 ml.		Choline chloride	1000
		(*p*-amino-benzoic acid)	25

Full details will be published elsewhere.

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[1] Begg and Robertson, *Nature*, **161**, 769 (1948).

Pregnancy Test using Male Anura

Confirming the validity of the Galli-Mainini test for pregnancy in the male toad *Bufo arenarum*[1] and referring to the suitability of *B. marinus*[2] and *Rana pipiens*[3], Haines[4] raises the question of the possible suitability of two European species, *B. bufo* and *R. temporaria*. We have demonstrated[5] the suitability of a European frog, *R. esculenta*; and on a theoretical basis we have assumed that the Galli-Mainini test must be common to the Anura (toads and frogs).

Meanwhile, many other species have been successfully employed in America (*B. paracnemis, B. crucifer, Calyptocephallus gayi, Leptodactillus ocellatus, Xenopus lævis, Odontophrynus, B. d'Orbigny*[6], *R. catesbeiana*[7]) and in Europe (*B. vulgaris, B. viridis*[8], *B. calamita*[9]).

Fifteen species of toads and frogs having been observed and found suitable, we think that the general hypothesis is largely confirmed. Although it will be practically impossible to establish with certainty that any male toad or frog at any time may be used, there is no special interest in such a theoretical security; for it is always possible to avoid false positive reactions by examination of the animal's urine before the test, and to avoid false negatives by previously testing each animal with urine of a woman known to be pregnant, the tested animal being fit for use after a week. From the latter point of view the testing of one animal from among a uniform batch will usually be sufficient, and the remaining animals can be used immediately.

There is one important difference between different species, namely, the size of the animal. The quantity of urine used should be approximately equal to one tenth of the average weight of the species utilized. No special precautions are necessary as regards the woman's urine; any specimen may be used directly. The activity is conserved at least for a week at room temperature[4]. We have obtained positive results with urine kept for a month in a refrigerator.

There is some doubt on the time convenient for certain results[6]. In a great majority of cases (all in our experience) positive reactions occur within two hours. It can be inferred that in the small percentage of cases of delayed response, the delay would not be greater than a further hour. As a positive reaction at two hours can never become negative at three, we propose to adopt a standard time of about three hours.

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Nov. 28.

[1] Galli-Mainini, C., *Sem. méd.* (Buenos Aires), **60**, 337 and **70**, 447 (1947).
[2] Lima, O. B., and Pereira, O. G., *Nature*, **161**, 676 (1948).
[3] Wiltberger, P. B., and Miller, D. F., *Science*, **107**, 198 (1948).
[4] Haines, M., *Nature*, **162**, 416 (1948).
[5] Aznar-Ferreres, J., *Laboratorio* (Granada), **5**, 535 (1948).
[6] Reports of several authors compiled by C. Galli-Mainini, *J. Amer. Med. Assoc.*, **138**, 121 (1948).
[7] Olivella, Martell and Benach, quoted by Anido Fraguio, V., and Anido Fraguio, G., "Laboratorio Clínico", **2** (second edit., Cultural S.A., La Habana, 1948).
[8] Cerquiglini, S., *Bol. Soc. Ital. Biol. Sper.*, **24**, 225 (1948).
[9] Creze, J., and Fonty, P., *Ann. Biol. Clin.*, **6**, 326 (1948).

University Education in Natural Science

In the leading article in *Nature* of April 30, attention is rightly directed to the high degree of specialization which is now demanded of our science graduates, a degree of specialization which, as is said there, "too often begins", and as I should say because of university scholarship demands, "usually begins", at school.

A re-organisation of university teaching is clearly long overdue, but it is doubtful whether it will be as difficult as that article suggests. Is not the obvious solution that which I put forward at the meeting of the British Association at Brighton last year, namely, that the first science degree for undergraduates should normally be a general science degree? I say "normally" because there is no reason why the special honours degree should not be retained for exceptional cases. But for the ordinary scientific student, surely a degree in a number of interrelated subjects is what is required. "It gives a student a grounding in a variety of subjects and, if it is properly taught, of necessity it shows the interrelationships of those subjects, and it does not lead to that completely unintellectual isolation which results so often from the special honours degree."

Many people, of course erroneously, consider a general degree as something new and something inferior; but it is not. The first part of the Cambridge Natural Sciences Tripos is a general honours degree, and it is certainly neither new nor inferior. This is the principle on which I have acted for years at Manchester. Students who wish to specialize in zoology are normally advised to take a general science course. If they then obtain a first-class or a good second-class, clearly they are fitted for further study and can be advised to specialize in a postgraduate year. For such an extension of their studies money is nowadays forthcoming; but it is only reasonable that such an extra year's work should carry with it a further degree, and why not a master's degree? In Manchester, for such a degree there is no need for the work to be original research. It can alternatively consist "of an essay on some scientific question of importance involving criticism or historical research". It is an easy matter for a head of a department to interpret this latter alternative so as to include whatever degree of specialization he considers necessary at such a level.

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Another Little-known History of Botany

In *Nature* of May 7, p. 732, Dr. Jules Brunel inquires about the "L. G." who was responsible for the "Précis de l'Histoire de la Botanique", the last of the seventeen volumes of "Le Règne Végétal", by O. Réveil, and others, Paris, 1870–71. The work in question is not accessible to me; but I find that, in the catalogue of the Library of the British Museum (Natural History), "L. G." is identified as "L. Gérard". I do not know on what evidence this is based; I have been unable to trace any botanist of this name who might be the writer of the "Précis". Louis Gérard is too early in date, as he was born in 1733. Dr. Brunel's tentative identification with L. Guérin is perhaps more probable; but it can hold only if the work is considered to be within the compass of a man who does not seem to have been a botanist. This is possible, as the "Précis" describes itself as "Biographique et Bibliographique". As another alternative—though a speculative one—I should like to suggest Lazare Garreau, who was professor at Lille. He was born at Autun in 1812, and published papers on physiological botany in the decade 1850–60. He was apparently still living when the second edition of Pritzel's "Thesaurus literaturæ botanicæ" appeared (1872).

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EFFECT OF LIGHT ON THE COMBUSTION OF HYDROCARBONS

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THE slow combustion of hydrocarbons in general takes place by a kinetic process which Semenov[1] described as a chain reaction showing 'degenerate branching'. According to this conception, the hydrocarbon is first oxidized to a moderately stable intermediate, which is itself oxidized to the final products, namely, carbon monoxide, water, etc. Thus a stationary concentration of the intermediate is built up during the reaction, which reaches a maximum at the time of maximum velocity. According to Semenov's conception, the intermediate is responsible for the starting of new chains by an alternative reaction with oxygen, and a delayed or degenerate branching results.

In the case of methane[4] and ethylene, the intermediate may be identified with formaldehyde, which, as shown by Bone, Haffner and Rance[2] and by Harding and Norrish[3], reaches a maximum concentration at the point of maximum velocity, and which when added to the reactants in the right amount (*c.* 1·0 per cent) completely removes the induction period[4].

The complete scheme derived for the oxidation of methane[4], based on the work of Norrish and Foord on methane[4] and Axford and Norrish[5] on the oxidation of formaldehyde, is as follows:

k_1 CH_4+O_2	$=CH_3O+H_2O$	Initiation and degenerate branching
k_2 H_2CO+O_2	$=HCO_3+O$	
k_3 $O+CH_4$	$=CH_3+OH$	
k_4 $OH+CH_4$	$=CH_3+H_2O$	Propagation
k_5 CH_3+O_2	$=H_2CO+OH$	
k_6 CH_3O+OH	$=CO+H_2O+H$	Coupled formaldehyde chain*
k_7 $H+O_2+H_2CO$	$=CO+H_2O+OH$	
k_8 $H+O_2+X$	$=HO_2+X'$	Termination*
k_9 $OH+$surface	$\rightarrow$ termination	

* Reactions (7) and (8) are only formally to be regarded as ternary reactions. The transition complex HO_3 formed with *c.* 50 k.cal. is unstable unless deactivated (reaction (8)), and reactive only if it encounters a formaldehyde molecule (reaction (7)) before it decomposes, or is deactivated.

In this mechanism, the concentration of formaldehyde, initially zero, grows very slowly at first, during the induction period; and later, as the delayed branching by reaction (2) takes effect, at an ever-increasing rate. But the rate of the oxidation of formaldehyde by reactions (6) and (7), which as is generally agreed depends approximately on the square of its concentration, grows still faster, so that eventually a stationary concentration is reached when its rate of destruction is equal to its rate of production. At this point the velocity of reaction must cease to increase; it settles down to a steady value which finally falls off as the reactants are consumed. Thus we get the familiar S-shaped pressure–time curves. A similar scheme has been derived for the oxidation of ethylene[6].

The steady rate is readily shown to be given by the kinetic equation[6]

$$\frac{-d(\mathrm{Hy})}{dt} = \frac{k_4}{k_9}\left(k_3(\mathrm{Hy})(O_2) + \frac{k_3k_4k_7(\mathrm{Hy})^2(O_2)Pd}{2k_7k_9\sigma + 2k_6k_9P^2d}\right), \quad (1)$$

where (Hy) stands for methane or ethylene, σ the specific surface activity per square cm. for termination by reaction (9), P the total pressure in the system and d the diameter of the reaction vessel. The first term on the right-hand side represents the initiation process, the second the propagation; and the former is generally negligible in comparison with the latter. With methane, the first term in the denominator is large compared with the second, which can be neglected; with ethylene, which oxidizes at a lower temperature, the two terms are of comparable magnitude. This circumstance is responsible for minor differences in their oxidation kinetics.

This general view of the oxidation of methane and ethylene led us to the conclusion that the combustion reaction should be accelerated by light, which is known to dissociate formaldehyde into free radicals, for the degenerate branching reaction (2) would now be augmented by the photochemical process

$$H_2CO + h\nu = H + HCO$$
$$\searrow$$
$$H + CO$$

as a chain-starting mechanism.

If the rate of absorption of light by formaldehyde is given by $k(H_2CO)I$, where I is the incident intensity, the rate equation now becomes modified to

$$\frac{-d\mathrm{Hy}}{dt} = \frac{k_4}{k_9}\left(k_3(\mathrm{Hy})(O_2) + k(\mathrm{Hy})I + \frac{k_3k_4k_7(\mathrm{Hy})^2(O_2)Pd + kk_4k_7(\mathrm{Hy})^2IPd}{2k_7k_9\sigma + 2k_6k_9P^2d}\right). \quad (2)$$

Subtracting the rate in the dark (R_D) from the rate in the light (R_L) we obtain:

$$R_L - R_D = \frac{k_4}{k_9}\left(k(\mathrm{Hy})I + \frac{kk_4k_7(\mathrm{Hy})^2IPd}{2k_7k_9\sigma + 2k_6k_9P^2d}\right); \quad (3)$$

or, keeping σ, I and d constant:

$$R_L - R_D = (\mathrm{Hy}) + \frac{a(\mathrm{Hy})^2P}{b + cP^2}. \quad (4)$$

If, in addition, the total pressure P be kept constant by making up with nitrogen,

$$R_L - R_D = (\mathrm{Hy}) + K(\mathrm{Hy})^2. \quad (5)$$

These predictions have all been confirmed. We used a cylindrical quartz reaction vessel (diameter 3·4 cm., volume 175 c.c.) in a horizontal electric furnace lined with polished aluminium with a quartz window 7 cm. in diameter at one end. A beam of light of high intensity obtained from a high-pressure point-source mercury arc, burning 1 kW., and 'cooled' by passing through 50 cm. of water contained in a tank with parallel quartz sides, was focused into the furnace by means of a searchlight mirror of polished aluminium. The reaction was followed by pressure change, measured by a glass spoon gauge sensitive to a pressure of 0·05 mm. mercury. Fig. 1 shows a typical result.

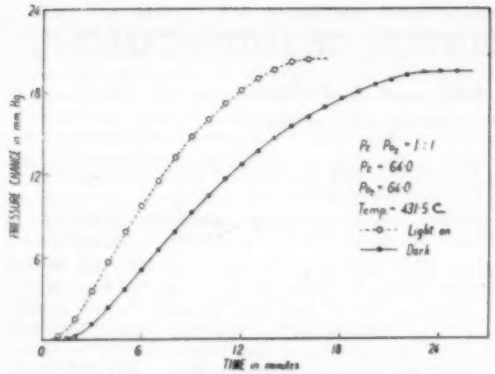

Fig. 1. Effect of light on the slow oxidation of ethylene

When the light beam was passed through a colour filter of 0·5 per cent solution of quinine hydrochloride 7 cm. thick, which cuts out all light of wave-length shorter than 3600 A., the acceleration due to the light was very nearly (90 per cent) suppressed. The formaldehyde absorption spectrum extends from 3750 A. to beyond 2500 A., whereas the spectrum of the lamp extended to 2450 A.; thus the active light lies in the ultra-violet in the region covering the absorption band of formaldehyde. With a more concentrated solution of quinine hydrochloride (2·5 per cent) cutting out all light of less than 4000 A., the effect was completely suppressed.

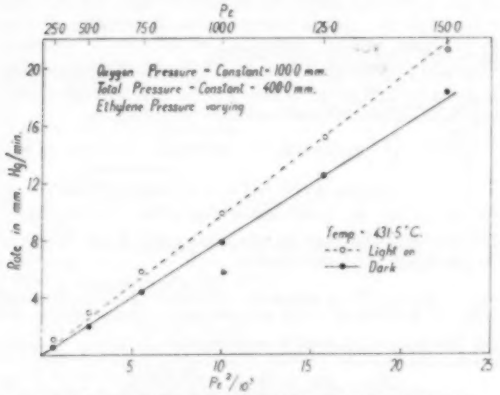

Fig. 2. Effect of light on the slow oxidation of ethylene; ethylene varying, total pressure constant

Figs. 2–5 show that R_L and R_D conform to equations (1) and (2), and that $R_L - R_D$ is independent of (O_2) and approximately proportional to $(Hy)^2$, as is required by equation (4) if the terms in Hy (initiation) are small compared with the terms in Hy^2 (propagation), and if b is large compared to cP^2, as it is in the case of methane. With ethylene we kept the total pressure P constant by adding nitrogen, and therefore $R_L - R_D$ is given by equation (5). Under these conditions, when (Hy) is small the first term in equation (5) preponderates, and $(R_L - R_D)$ is more nearly proportional to (Hy) than $(Hy)^2$. The fact that the experimental points for low (Hy) in Fig. 2 lie above the line is in accord with this.

By working close to the ignition limit with ethylene (C_2H_4 = 225 mm., O_2 = 318, temp. 431° C.) we were readily able to convert a 'slow' dark reaction into an ignition by irradiation; but in this region equation (1) is no longer obeyed owing to the large measure of self-heating as the ignition limit is approached.

These results accord well with the reaction scheme based on formaldehyde outlined above, and confirm the kinetic formulæ previously deduced. They show, in effect, that the degenerate branching process can be powerfully affected by light without altering the character of the reaction; and the effect is all the more striking when it is remembered that the initial reactants are completely transparent to the light used.

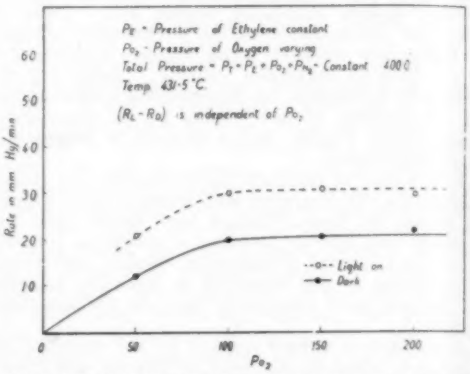
P_E = Pressure of Ethylene constant
P_{O_2} = Pressure of Oxygen varying
Total Pressure = $P_T = P_E + P_{O_2} + P_{N_2}$ = Constant 400·0
Temp. 431·5°C.
$(R_L - R_D)$ is independent of P_{O_2}
Rate in mm. Hg/min.
Light on
Dark
P_{O_2}

Fig. 3. Effect of light on the slow oxidation of ethylene; oxygen varying, total pressure constant

By using the weaker colour filter (0·5 per cent quinine hydrochloride) it was shown that the effect still persists feebly in light the spectrum of which lies between 3600 A. and 4000 A. Now the predissociation limit of formaldehyde as shown by the threshold of fluorescence is at c. 3000 A. [7], and it must therefore be concluded that some such reactions as

$$H_2CO + h\nu = H_2CO'$$
$$H_2CO' + O_2 = H_2CO_3 + O$$

take place in this region; that is, that reaction (2) is somewhat enhanced by light which excites, but does not split, the formaldehyde molecule.

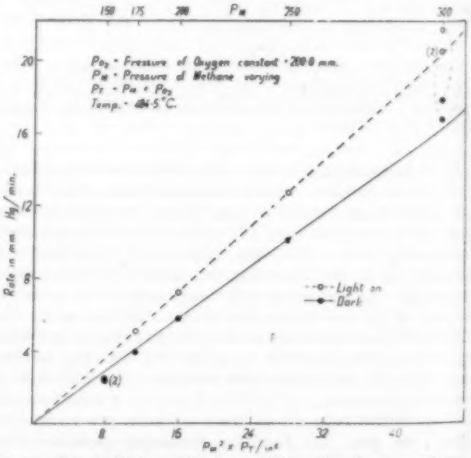

Fig. 4. Effect of light on the slow oxidation of methane; methane varying

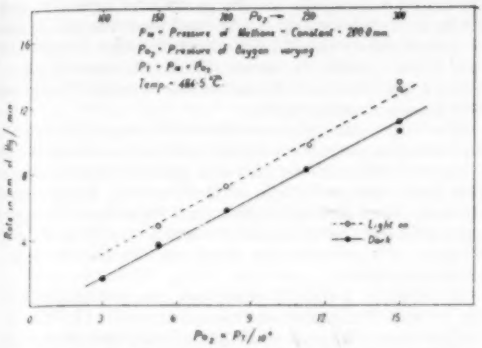

Fig. 5. Effect of light on the slow oxidation of methane; oxygen varying

With heavier hydrocarbons the characteristics of degenerate branching are similarly observed, and we believe that the heavier aldehydes which are first produced are similarly responsible for the delayed branching reaction. On this basis it is possible to build a self-consistent mechanism of a pattern resembling the simpler reactions treated here[6]. It is significant that light readily accelerates the oxidation of butane, and the shapes of the curves in the dark and in the light suggest different end points; it is probable that the phenomenon will be found to be general for hydrocarbons.

This photochemical effect provides a new experimental approach to the study of the reaction kinetics of combustion, and cannot fail to be revealing.

[1] Semenov, *Z. phys. Chem.*, 11B, 464 (1930); *Phys. Z. d. Sowjetunion*, 1, 546 (1932); "Chemical Kinetics and Chain Reactions", 68 (Oxford, 1935).
[2] Bone, Haffner and Rance, *Proc. Roy. Soc.*, A, **143**, 16 (1933).
[3] Harding and Norrish, *Nature*, **163**, 797 (1949).
[4] Norrish and Foord, *Proc. Roy. Soc.*, A, **157**, 503 (1936).
[5] Axford and Norrish, *Proc. Roy. Soc.*, A, **192**, 518 (1948).
[6] Norrish, communication to the Centre National de la Recherche Scientifique, Paris, 1948 (in course of publication).
[7] Herzberg and Franz, *Z. Phys.*, **76**, 720 (1932). Gradstein, *Z. phys. Chem.*, B, **22**, 384 (1933).

OPTICAL PROPERTIES OF SOLID THIN FILMS

A MOST successful international colloquium on the optical properties of solid thin films was held at Marseille during the week April 19–23 under the auspices of the Centre National de la Recherche Scientifique. Some forty-four physicists attended by invitation, and, of these, twenty-five contributed papers. There was, of course, a strong contingent from France, including, among others, P. Jacquinot, M. Perrot and P. Rouard. From Great Britain contributions were read by K. M. Greenland, O. S. Heavens, H. Kuhn and S. Tolansky. The United States were represented by B. H. Billings, N. W. Scott, J. Strong and A. F. Turner, the Netherlands by P. van Alphen and B. Blaisse, Italy by M. Ballerini, Switzerland by M. Schaetti and Czechoslovakia by A. Vasicek.

The conference was well organised by Prof. P. Rouard, director of the physical laboratory in the University of Marseille, and was characterized by smooth, efficient working and excellent programme planning. This meeting was held in a provincial university as part of deliberate policy of the Centre National de la Recherche Scientifique, which is arranging a series of international conferences in French provincial university centres. The choice of Marseille for this particular subject of optical properties of thin films was a happy one indeed; for it was there, at the beginning of this century, that Fabry laid the foundation of the very subject under discussion, and it was there, too, under his inspiration that the branch of classical optics associated with the names of Fabry, Buisson, Macé de Lepinay and others was created. Indeed, the visitors all derived considerable pleasure from an exhibition of the original apparatus used by these masters of experimental optics, and were much moved, too, by listening to a recording of the voice of Fabry.

Although a considerable number of papers were read (many contributors read several: for example, the writer contributed five), these all crystallized into four fairly distinct groups: (*a*) determination of optical properties and thickness of thin metal or dielectric films; (*b*) the principles and applications of multiple-beam interferometry; (*c*) preparation of interferometric wave-length filters and discussion of their characteristics; (*d*) improving the optical properties of surfaces by deposition of multiple films with alternate low and high refractive indices.

The conference opened with a session of theoretical papers on the properties of single and multiple thin films, and then plunged into its main work, which consisted of formal papers on experimental aspects connected with the properties and optics of thin films. Occasionally the conference assumed the character of informal discussions on experimental techniques, yet all were agreed that these informal exchanges constituted one of the most valuable features of the whole conference. For it is a fact that success with experimental interferometry, or with those other branches of applied optics which involve surface deposition of films, depends largely upon minor details of personal techniques which are not easily publishable, and are, indeed, often even difficult to describe. For example, a most lively discussion ensued simply on the question of the best method of cleaning a glass surface which is to accept a film by deposition by vacuum evaporation. There were perhaps ten speakers, with the inevitable result that perhaps ten distinctly different techniques were described; but all had one thing in common, namely, final cleaning by ions with a gas discharge. It appears that any reasonable method of cleaning is satisfactory provided the glow discharge is the final cleansing agent.

Many striking and novel optical results were described, and it is anticipated that all the papers contributed will be published together in some form. Such a collection will make a notable contribution to a subject rapidly becoming of considerable importance to technical optics, particularly those fields concerned with either reduction or enhancement of reflectivities of surfaces. The conference was an unqualified scientific success and equally successful socially, thanks largely to Prof. Rouard. The visitors will long remember the magnificent hospitality of their French colleagues. A visit was paid to the astronomical observatory at St. Michel, the visit being of mutual benefit to visitors and residents, for the astronomers there were glad to welcome so much expert opinion on the problems associated with the coating of the mirrors of their reflector telescopes.

On the break-up of the conference everyone felt that he was carrying away many new techniques, little tricks of the trade and valuable 'know-hows', for there was a very frank exchange of knowledge, even from those who represented large commercial organisations, and who might have been forgiven for hesitating to release trade secrets. There were, in fact, no such hesitations, either from the commercial or government representatives who attended, and, indeed, the liaison between the industrial and academic research workers was all that could be desired.

S. TOLANSKY

PHYSICAL SOCIETY

ANNUAL MEETING

AT the annual general meeting of the Physical Society, held at the Royal Institution on May 6, the reports of the Council and Treasurer and the accounts and balance sheet for 1948 were presented and adopted, and the officers and Council for 1949–50 were elected as follows: *President*, Prof. S. Chapman; *Vice-Presidents* who have filled the office of president, Prof. C. H. Lees, Sir Frank Smith, Sir Owen Richardson, Dr. W. H. Eccles, Prof. A. O. Rankine, Mr. T. Smith, Dr. Allan Ferguson, Sir Charles Darwin, Prof. E. N. da C. Andrade, Prof. D. Brunt, Prof. G. I. Finch; *Vice-Presidents*, Dr. W. D. Wright, Dr. W. Jevons, Mr. C. H. Collie, Prof. R. Peierls; *Honorary Secretaries*, Mr. C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Dr. H. Shaw; *Honorary Librarian*, Dr. R. W. B. Pearse; *Members of Council*, Dr. D. Roaf, Dr. A. C. G. Menzies, Dr. F. C. Toy, Mr. J. H. Awbery, Prof. L. F. Bates, Dr. R. C. Evans, Prof. L. C. Martin, Dr. C. E. Wynn-Williams, Dr. A. G. Quarrell, Dr. A. B. Wood, Prof. Willis Jackson, Prof. H. S. W. Massey.

The officers for 1949–50 of the four Groups of the Society are as follows: *Colour Group:* Chairman, Dr. W. S. Stiles; Honorary Secretary, Mr. R. G. Horner. *Optical Group:* Chairman, Prof. L. C. Martin; Honorary Secretary, Mr. G. S. Speak. *Low Temperature Group:* Chairman, Prof. F. E. Simon; Honorary Secretary, Dr. G. G. Haselden. *Acoustics Group:* Chairman, Mr. H. L. Kirke; Honorary Secretaries, Mr. W. H. Allen and Mr. A. T. Pickles.

During 1948, which the Council report states was a satisfactory year for the Society, there was a net increase in the membership of some six per cent, making the total at the end of the year only a few short of two thousand. Despite the increase in the fellows' annual subscription from two to three guineas, there were very few resignations and lapses. The financial position, though somewhat improved, still gives cause for anxiety.

In addition to the ordinary science meetings, a two-day summer meeting devoted to microwave spectroscopy was held at the Clarendon Laboratory, Oxford, and a full-day meeting at the Research Department of Metropolitan-Vickers Electrical Co., Ltd., Manchester, on surface structure and electrical properties of semiconductors. Prof. E. O. Lawrence was elected an honorary fellow in May, and Prof. R. W. Wood, one of the honorary fellows of the Society, lectured at one of the science meetings on the spontaneous deformation of crystals. The thirty-second Guthrie Lecture was delivered by Sir George Thomson, who spoke on the growth of crystals, and Profs. S. Tolansky and Y. Rocard were the recipients of the fourth (1948) Charles Vernon Boys Prize, and the third (1948) Holweck Prize of the Physical Society and Holweck Medal of the Société Française de Physique, respectively.

The thirty-second exhibition of scientific instruments and apparatus, held in April, had an attendance of about 9,400 visitors, and was again a great success. The four subject-Groups of the Society, the Colour, Optical, Low Temperature, and Acoustics Groups, have all been active during the year, and brief details of their composition and meetings are listed in the annual report.

In addition to the *Proceedings*, the publications of the Society during the year included: vol. 11 (1946–47) of *Reports on Progress in Physics*; and special reports such as the "Report on Colour Terminology", the "Strength of Solids", a report of the 1947 Bristol Conference, and "Emission Spectra of the Night Sky and Auroræ". In order to cope with the increased number of papers suitable for publication in the *Proceedings*, and to expedite publication, it was decided that from January 1949 the *Proceedings* should appear monthly in two sections, section *A* covering atomic and sub-atomic physics, including such subjects as crystal structure, quantum mechanics and spectra, and section *B* macroscopic physics, including such subjects as acoustics, optical design and radio. A new feature, introduced in 1948 and now appearing regularly in the *Proceedings*, is "Letters to the Editor", a section similar to that of the same name appearing in *Nature*.

It is to be hoped that the sales of the special reports will improve, so that the decision of the Council to curtail the production of these reports will be rescinded.

S. WEINTROUB

THE SMITHSONIAN INSTITUTION

REPORT FOR 1947–48

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1948*, again emphasizes the handicap placed on the work of the Institution by shortage of staff and of adequate buildings. Additions to the collections of the National Museum during the year numbered 507,000, and field parties from the Museum visited Arnhem Land in Australia, the antarctic continent, the Bikini area in the Pacific, the Persian Gulf, Colombia, Panama, and other parts of the world. The Department of Biology has been divided into those of Zoology and Botany, and the Division of Aeronautics has become the nucleus of the National Air Museum.

The director of the Bureau of American Ethnology conducted archæological excavations in western Panama in co-operation with the National Geographic Society, discovering a new, very early culture, while the associate director of the Bureau was occupied mainly with the river basin surveys. Surveys made in eighteen States and thirty-eight reservoir areas have led to 250 sites being recommended for excavation to recover archæological material which might be lost through the construction of dams and river valley reservoirs. An autonomous unit of the

* Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1948. (Publication 3952.) Pp. ix+158. (Washington, D.C.: Government Printing Office, 1948.) 55 cents.

Bureau, the Institute of Social Anthropology, gave courses in anthropology and conducted co-operative field work in Brazil, Columbia, Mexico and Peru.

The International Exchange Service made the first shipments of exchange publications to Japan since the War, and now sends consignments to all countries except Roumania. In return for similar material received from other countries, ninety-four sets of United States official publications, seventy-three copies of the Federal Register, and sixty-six copies of the Congressional Record were sent abroad. Visitors to the National Zoological Park increased by more than 300,000, and the collection at the close of the year totalled 2,797 animals representing 690 different species. The Astrophysical Observatory terminated the sun and sky radiation studies at Camp Lee, but similar studies will continue at the Montezuma and Miami stations. Promising sites for a new high-altitude station were located in Mexico, southern California, and the Hawaiian Islands. The Division of Radiation and Organism substantially completed its studies of the respiration of broad-leaf plants, the effects of environmental factors on the germination of lettuce seeds, and the developmental physiology of grass seedlings.

A total of 165,740 copies of Smithsonian publications was distributed during the year, and a complete list of the publications during the year is appended. The Library received 53,129 publications, and 36,701 pieces from its collection of duplicates were selected for destroyed libraries overseas. About half the 915,987 volumes of the Library are housed as the Smithsonian Deposit in the Library of Congress. The financial report of the executive committee of the Board of Regents and the usual departmental reports are appended.

LICHENS OF ANTARCTICA

IN a vegetation devoid of vascular plants, as the antarctic continent is generally believed to be, the lichens assume a quite unusual importance. The meticulous study of the lichens of Antarctica and the subantarctic islands recently published (B.A.N.Z., Antarctic Research Expedition Report. Vol. 7, Lichens and Lichen Parasites, by C. W. Dodge. Adelaide, 1948) is therefore a very significant contribution to knowledge of these remote and inhospitable regions, incomplete as it must necessarily be.

The material was collected by several different expeditions, the Australian Antarctic Expedition of 1911–14, the British, Australian, New Zealand Expedition of 1929–31, and there is some residual material from the British Antarctic Expedition of 1907–9. Unfortunately, a large part of the collections from the subantarctic islands of the Indian Ocean visited by the 1929–31 expedition was lost during the bombing of London, having accidentally been sent to the British Museum; but it is indeed fortunate that the bulk of the collections had been sent to the Herbarium of the Missouri Botanic Garden, in which the most complete set has been retained, and that Dr. Dodge was free to devote the very considerable amount of skilled attention to them that this publication obviously shows.

It is not profitable to summarize the purely taxonomic side of the work which will only concern the specialist, but no plant geographer can afford to ignore the implications of geographical distribution outlined in the introduction. Three totally distinct floras are discerned, that of Antarctica itself, which is still very imperfectly known, that of Macquarie Island, which seems wholly unrelated to it though with some affinities with both New Zealand and Tasmania, and thirdly "Kerguelia", which is the name used to cover Kerguelen Island, Heard Island, the Crozets and Prince Edward Island groups.

The lichen flora of Kerguelia is remarkable for the very high proportion of endemism in it, possibly all, and certainly 118 out of the total of 124 known species, being in this category. This can only mean very prolonged isolation. The generic affinities, many of which are also endemics, are, however, of even greater interest since they seem to imply remote physical connexions of some kind over immense distances in the most diverse directions, which include Fuegia, the Auckland Islands, South Africa and the Andes. Evidence of this kind, though insufficient in itself to establish major hypotheses such as that of continental drift, is nevertheless closely cognate to any discussion of such problems. This is perhaps the most important aspect of the study of lichen distribution in the southern hemisphere, since lichens, more perhaps than any other form of plant life, have special limitations in their mode of distribution over long distances. It is therefore greatly to be hoped that further contributions will in due course be made to this very promising, though hitherto much neglected and difficult, field of inquiry.

FORTHCOMING EVENTS

Tuesday, June 7

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. A. C. Crombie: "Theory and Experiment in the Science of Robert Grosseteste"; Mr. H. C. King: "The Optical Work of Charles Tulley".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Åke Campbell: "The Colonization of Lappland and Culture Contacts between Farmers and Nomads".

Wednesday, June 8

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Combustion of Hydrocarbons".

Thursday, June 9

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Symposium on "Stochastic Processes".

RESEARCH DEFENCE SOCIETY (at Manson House, Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting; Prof. C. Lovatt Evans, F.R.S.: "Physiological Research and the Vivisection Act" (Eighteenth Stephen Paget Memorial Lecture).

Friday, June 10

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. T. Smith, F.R.S.: "The Contributions of Thomas Young to Geometrical Optics, and their Application to Present-day Questions" (Thomas Young Oration). (Members of the Optical Group are invited.)

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. S. W. Wooldridge: "The Structure and Morphology of the Country around Fernhurst, Sussex".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (June 11).

LECTURERS IN BIOLOGICAL SUBJECTS (Botany and Zoology)—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (June 11).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, The University, Liverpool (June 11).

READERSHIP IN APPLIED PHYSIOLOGY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 13).

LECTURER IN ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (June 15).

DIRECTOR OF THE COMMONWEALTH BUREAU OF DAIRY SCIENCE, Shinfield, Reading—The Secretary, Commonwealth Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (June 15).

SENIOR LECTURER (Grade I) IN HORTICULTURAL SCIENCE—The Secretary and Registrar, The University, Bristol (June 20).

LECTURER or an ASSISTANT LECTURER IN MECHANICAL ENGINEERING, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (June 20).

BRITISH COKE RESEARCH ASSOCIATION FELLOWSHIP—The Registrar, King's College, Newcastle-upon-Tyne (June 21).

GAS LIGHT AND COKE COMPANY RESEARCH FELLOWSHIP IN GASEOUS FUEL AND COMBUSTION—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 24).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Leeds 2 (June 25).

RESEARCH OFFICER IN THE WOOL TEXTILE RESEARCH SECTION (Ref. No. 2031), at Geelong, and a RESEARCH OFFICER IN THE DIVISION OF INDUSTRIAL CHEMISTRY (Ref. No. 2159), at Fishermen's Bend, Melbourne, of the Australian Council for Scientific and Industrial Research—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (June 25).

ASSISTANT LECTURER IN BOTANY, and ASSISTANT LECTURERS (2) IN ZOOLOGY—The Registrar, The University, Reading (June 27).

AGRICULTURAL ECONOMIST in the Department of Agriculture—The Registrar, The University, Leeds 2 (June 27).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Birmingham 3 (June 30).

EXPERIMENTAL OFFICERS (2, one for work on cereal breeding, and the other for work on potato breeding), a SCIENTIFIC OFFICER for work on genetical and cytological problems, and a SENIOR SCIENTIFIC OFFICER to work on geneco-ecological problems of the herbage plant section dealing with the distribution of intra-specific variation in wild and cultivated plants—The Secretary, Scottish Society for Research in Plant Breeding, 8 Eglinton Crescent, Edinburgh 12 (June 30).

SENIOR LECTURER IN ENGINEERING PHYSICS, SENIOR LECTURERS (2) IN ELECTRICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2576 (June 30).

CURATOR OF THE DEPARTMENT OF NATURAL HISTORY in the Museum, Kelvingrove, Glasgow—The Town Clerk, City Chambers, Glasgow, C.2, endorsed 'Curator of the Department of Natural History' (June 30).

SENIOR LECTURERS IN VETERINARY PATHOLOGY, IN VETERINARY ANATOMY, and IN VETERINARY PHYSIOLOGY—The Secretary and Registrar, The University, Bristol (June 30).

RESEARCH OFFICERS (3) to work on sugar beet breeding, leguminous forage crop breeding, and cytogenetic investigations—The Secretary, School of Agriculture, Cambridge (June 30).

UNIVERSITY LECTURER IN THEORETICAL ELECTRODYNAMICS AND RADIO—Dr. F. B. Kipping, Chemical Laboratory, Cambridge (July 1).

EXPERIMENTAL OFFICER for supervision of metallurgical laboratory, and an ASSISTANT EXPERIMENTAL OFFICER for interpretation of analyses primarily with casting, hot and cold working of non-ferrous alloys, in a Ministry of Supply factory in Co. Durham—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.366/49A (July 6).

INSPECTOR UNDER THE DANGEROUS DRUGS ACTS, in the Home Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2596 (July 7).

READERSHIP IN ANATOMY at Guy's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 7).

LECTURER IN FORESTRY—The Secretary, The University, Aberdeen (July 21)

SENIOR LECTURER IN MATHEMATICS (Statistics) at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 30).

RESEARCH CHEMIST for work on the development of new methods of chemical analysis—The Director, British Cast Iron Research Association, Alvechurch, Birmingham.

ENTOMOLOGIST (male) for service with a research unit undertaking a large-scale mosquito eradication experiment in Mauritius using D.D.T. and B.H.C. insecticides—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER (Grade II) IN ORGANIC CHEMISTRY, an ASSISTANT LECTURER IN PHYSICAL CHEMISTRY, a DEMONSTRATOR IN PHYSICAL CHEMISTRY, and a DEMONSTRATOR IN ORGANIC CHEMISTRY—The Registrar, The University, Nottingham.

SENIOR TECHNICIAN and a TECHNICIAN IN THE DEPARTMENT OF PATHOLOGY—The Superintendent, Royal Infirmary, Infirmary Road, Sheffield 6.

LECTURER IN THE DEPARTMENT OF CHEMISTRY AND METALLURGY, and a LECTURER IN THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10.

AGRICULTURAL CHEMISTS in the Colonial Service in East Africa, West Africa and the Federation of Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

TECHNICIAN (Grade IV) IN THE DEPARTMENT OF PHYSICS—The Secretary, University College, Gower Street, London, W.C.1, quoting Physics/3.

SENIOR ASSISTANT for the teaching of Organic Chemistry up to Final Special B.Sc. standard, and a LECTURER IN MATHEMATICS to B.Sc. Engineering and B.Sc. General Degree—The Principal, Medway Technical College, Gillingham.

ASSISTANT EXPERIMENTAL OFFICERS (covering a wide variety of scientific, including engineering, qualifications) in various Government Departments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2522.

VETERINARY RESEARCH OFFICER in the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation, for work in connexion with the trypanocidal drug 'Antrycide', and a VETERINARY RESEARCH OFFICER (Animal Husbandry) in the East African Veterinary Research Organisation—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR LECTURER IN BUILDING SCIENCE at the Leeds College of Art (School of Architecture)—The Director of Education, Education Offices, Leeds 1.

UNIVERSITY LECTURERS (2) IN MATHEMATICS (with special qualifications either in Algebra or in Quantum Theory), and UNIVERSITY ASSISTANT LECTURERS (2) IN MATHEMATICS—Dr. A. J. Ward, Emmanuel College, Cambridge.

SUPERINTENDING PHARMACEUTICAL CHEMIST for the Medical Department, Government of Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 18288/3F.

LABORATORY TECHNICIAN (Grade III) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1, quoting Pharmacology/2.

CHIEF CHEMIST for the Process Control Laboratory, East African Industrial Management Board, Nairobi, Kenya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21789/3E.

ELECTRICAL ENGINEERS for the Electricity Department of the Federation of Malaya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27326/18.

TECHNICIAN FOR HAEMATOLOGICAL DEPARTMENT—The Director, Ashford Hospital, Ashford, Middx.

CEREALIST for the Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18187/3F.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

B.I.O.S. Overall Report No. 17: The Jute Industry in Germany during the Period 1939–1945. Prepared by the British Jute Trade Research Association. Pp. 24. (London: H.M. Stationery Office, 1949.) 6d. net. [72

British Museum (Natural History). Great Barrier Reef Expedition, 1928–29. Scientific Reports, Vol. 2, No. 9: The Seasonal and Vertical Distribution of the Copepoda. By G. P. Farran. Pp. 291–312. (London: British Museum (Natural History), 1949.) 7s. 6d. [72

Forestry Commission. Fifth British Empire Forestry Conference, Great Britain, 1947. Proceedings. Pp. 280. (London: H.M. Stationery Office, 1948.) 10s. net. [72

General Information concerning the Courses in Natural Science at Oxford and Cambridge. Prepared for the use of Candidates for Admission to the Women's Colleges. Pp. 12. (Oxford: B. H. Blackwell, Ltd.; Cambridge: Bowes and Bowes, 1949.) 1s. net. [72

British Standard 1460: 1948. Precipitated Calcium Carbonate (Determination of Density after Compaction). Pp. 12. (London: British Standards Institution, 1948.) 2s. net. [102

British Industries Fair 1949, Olympia and Earls Court, London, 2nd to 13th May. Organised by the Board of Trade. Special Overseas Advance edition. Pp. 576+Ad. 504. Advance edition, Alphabetical List of Exhibits in Foreign Languages. Pp. 144. British Industries Fair 1949, Engineering and Hardware Section, 2nd–13th May. Organised by the Chamber of Commerce, Birmingham. Advance edition. Pp. 144. (London: Board of Trade, 1949.) [102

Other Countries

United Nations Educational, Scientific and Cultural Organization. Report of the Director General on the Activities of the Organization in 1948. (Unesco Publication 226.) Pp. 119. (Paris: Unesco, 1948.) 7s. net. [142

Dialectica (International Review of Philosophy of Knowledge). Vol. 2, No. 3–4: The Concept of Complementarity. Edited by Wolfgang Pauli. Pp. 305–424. (Neuchâtel: Editions du Griffon, 1948.) 4.80 francs. [152

Field Museum of Natural History. Zoological Series, Vol. 13, Part 1, No. 3: Catalogue of Birds of the Americas and the adjacent Islands. Part 1, No. 3: Jacanidae—Rostratulidae—Haematopodidae, Charadriidae — Scolopacidae — Recurvirostridae, Palaropodidae—Burhinidae—Thinocoridae—Chionididae, Stercorariidae—Laridae—Rynchopidae—Alcidae. By Charles E. Hellmayr and Boardman Conover. (Publication 616.) Pp. vi+383. (Chicago: Field Museum of Natural History, 1948.) 4 dollars. [172

Sveriges Geologiska Undersökning. Ser. Ca, No. 36: The Alkaline District of Alnö Island. By Harry von Eckermann. Pp. 176+60 plates. (Stockholm: A. B. Kartografiske Institutet, 1948.) 10 kr. [212

Sugar Research Foundation. Scientific Report Series No. 11: The Chemical Production of Lactic Acid from Sugars. By Dr. Rex Montgomery. Pp. v+28. Free. Science Looks at Sugar. Fifth Report, 1948. Pp. 23. (New York: Sugar Research Foundation, Inc., 1949.) [212

Report of the Twenty-sixth Meeting of the Australian and New Zealand Association for the Advancement of Science, Perth Meeting, August 1947. Pp. 365. (Perth: Government Printer, 1948.) [13

Archiv für Meteorologie, Geophysik und Bioklimatologie. Herausgegeben von Dr. W. Mörikofer und Prof. Dr. F. Steinhauser. Serie A: Meteorologie und Geophysik. Band 1, Heft 1. Pp. 141. (Wien: Springer-Verlag, 1948.) [13